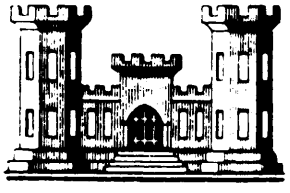
MILLERS RIVER WATERSHED
BIRCH HILL DAM
TULLY LAKE
MASSACHUSETTS & NEW HAMPSHIRE

CONNECTICUT RIVER BASIN

MASTER MANUAL
OF
RESERVOIR REGULATION
APPENDIX F



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

MAY 1974

20

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OF

RESERVOIR REGULATION

APPENDIX F

Department of the Army
New England Division, Corps of Engineers
Waltham, Massachusetts

January 1950
Revised May 1974

CONNECTICUT RIVER FLOOD CONTROL

MASTER MANUAL
OF
RESERVOIR REGULATION

Appendix	Watershed	Reservoirs	Status
Master Manual	Connecticut River	-	Started
A	Ompompanoosuc River	Union Village	Completed 1950 (Revised 1971)
B	Ottauquechee River	North Hartland	Completed 1969
C	Black River	North Springfield	Completed 1968
D	West River	Ball Mountain Townshend	Completed 1965 (Revised 1973)
E	Ashuelot River	Surry Mountain Otter Brook	Completed 1962 (Revised 1972)
F	Millers River	Birch Hill Tully	Completed 1950 (Revised 1974)
G	Chicopee River	Barre Falls Conant Brook	Completed 1964
H	Westfield River	Knightville Littleville	Completed 1967
J	Farmington River	Colebrook River Mad River Sucker Brook	Completed 1970

PREFACE

The Millers River watershed has a drainage area of 392 square miles and is located in north-central Massachusetts with a small portion in southwestern New Hampshire. The flood control plan for the watershed described in this manual includes two dams and reservoirs, namely Birch Hill Dam and Tully Lake, and a local protection project at Gardner, Massachusetts. Birch Hill Dam is located in the southeastern part of Royalston, Massachusetts and Tully Lake is in the southwestern corner of the same town.

This Appendix of the Connecticut River Master Regulation Manual includes a description of the basin; hydrologic, climatological and flood data, along with project descriptions and regulation procedures for all Corps projects. In addition to setting forth a method of reservoir regulation, the manual will serve as a reference source for future studies.

The manual is divided into seven chapters: Introduction, Management, Hydrometeorology, Communications, Hydrologic Forecasts, Reservoir Regulation and Hydrologic Equipment. The setup of chapters allows the reader to obtain desired general background information on any particular aspect of each project.

Pertinent data on the hydrologic information of the watershed, Birch Hill Dam and Tully Lake are shown on pages i, ii and iii, respectively, at the front of the manual.

The chapter on Reservoir Regulation contains detailed procedures and information necessary for regulating the protective works to provide protection for downstream communities on the Millers and Connecticut Rivers.

MANUAL OF RESERVOIR REGULATION
MILLERS RIVER WATERSHED
MASSACHUSETTS AND NEW HAMPSHIRE

APPENDIX F

RESERVOIR REGULATION MANUAL
MILLERS RIVER WATERSHED

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PERTINENT DATA
MILLERS RIVER WATERSHED
HYDROLOGIC INFORMATION

DRAINAGE AREA	Square Miles
MAIN STEM - MILLERS RIVER	
Near Winchendon, Mass. (USGS Gage)	83.0
At Birch Hill Dam	175
At South Royalston, Mass. (USGS Gage)	187
At Exchange Street Bridge, Athol, Mass.	206
At Main Street Bridge, Athol, Mass.	280
At Main Street Bridge, Orange, Mass.	316
At Erving, Mass. (USGS Gage)	375
At Mouth	392
TRIBUTARIES	
Tarbell Brook near Winchendon, Mass. (USGS Gage)	18.2
Priest Brook near Winchendon, Mass. (USGS Gage)	19.4
Otter River at Otter River, Mass. (USGS Gage)	34.2
Otter River at Mouth	60
East Branch Tully River at Tully Lake	50
East Branch Tully River near Athol, Mass. (USGS Gage)	50.4
Tully River at Mouth	74
Lake Rohunta Outlet near Athol, Mass. (USGS Gage)	20.3
Moss Brook at Wendell Depot, Mass. (USGS Gage)	12.3

TEMPERATURE	Birch Hill Dam Massachusetts (Degrees F.)	Tully Lake Massachusetts (Degrees F.)	Turners Falls Massachusetts (Degrees F.)
Mean Annual	46.0	47.9	45.3
Maximum Recorded	99 (Aug)	104 (July)	100 (July)
Minimum Recorded	-34 (Jan)	-30 (Feb)	-29 (Jan)
Years of Record (Through 1970)	22	74	21

PRECIPITATION	Winchendon Massachusetts (inches)	Birch Hill Dam Massachusetts (inches)	Tully Lake Massachusetts (inches)	Turners Falls Massachusetts (inches)
Mean Annual	41.69	37.52	41.07	40.32
Maximum Annual	59.98 (1938)	50.49 (1960)	54.28 (1951)	55.18 (1938)
Minimum Annual	28.26 (1965)	25.91 (1965)	27.67 (1964)	27.66 (1894)
Years of Record (Through 1970)	77	22	21	71

WATER EQUIVALENT IN SNOW COVER (Entire Watershed)

	1950 - 1972 Mean (inches)	Maximum (inches)	Minimum (inches)
1 February	2.0	4.2	0.3
15 February	2.5	5.6	0.0
1 March	3.4	7.6	0.0
15 March	3.6	7.7	0.0
1 April	2.3	8.2	0.0
15 April	0.4	4.9	0.0

USGS GAGES	Period of Record
Tarbell Brook near Winchendon, Mass.	May 1916 - To Date
Millers River near Winchendon, Mass.	Jun 1916 - To Date
Priest Brook near Winchendon, Mass.	May 1916 - To Date
Otter River at Otter River, Mass.	Dec 1964 - To Date
Millers River at South Royalston, Mass.	Jul 1939 - To Date
East Branch Tully River near Athol, Mass.*	Oct 1915 - To Date
Lake Rohunta Outlet near Athol, Mass.	Dec 1964 - To Date
Moss Brook at Wendell Depot, Mass.	Jun 1916 - To Date
Millers River at Erving, Mass.	Aug 1914 - To Date

*Gaging station relocated 300 feet downstream of Tully Lake on 26 October 1948 (prior location 0.2 mile upstream from present location.)

FLOW RECORDS	Priest Brook near Winchendon Massachusetts Date	Flow (cfs)	Millers River at South Royalston Massachusetts Date	Flow (cfs)	East Branch Tully River near Athol, Mass. Date	Flow (cfs)	Millers River at Erving Massachusetts Date	Flow (cfs)
Minimum Average Daily	4-8 Sep 29	0.08	4 Aug 56	9.3	7-10 Nov 61	0.01	6 Sep 26	8
Minimum Average Monthly	Sep 64	0.29	Sep 64	20	Sep 64	1	Aug 66	43
Minimum Average Annual	1965	8.2	1965	102	1965	23	1965	196
Maximum Average Daily	21 Sep 38	2,280	13-14 Apr 40	3,890	21 Sep 38	3,650	22 Sep 38	22,000
Maximum Average Monthly	Apr 40	225	Apr 40	1,850	Apr 40	528	Mar 36	3,989
Maximum Average Annual	1928	55.0	1960	490	1928	140	1938	1,012
Maximum Instantaneous	21 Sep 38	3,000	13 Apr 40	4,400	21 Sep 38	5,140	22 Sep 38	29,000
Average Discharge		32		304		80		610

PEAK FLOWS

Priest Brook Near Winchendon, Mass. Date	c.f.s.	c.s.m.	Millers River at South Royalston, Mass. Date	c.f.s.	c.s.m.	East Branch, Tully River Near Athol, Mass. Date	c.f.s.	c.s.m.	Millers River at Erving, Mass. Date	c.f.s.	c.s.m.
21 Sep 38	3,000	155	13 Apr 40	4,400	24	21 Sep 38	5,140	102	22 Sep 38	29,000	78
18 Mar 36	1,840	95	25-26 Jun 44	2,830	15	18-19 Mar 36	3,700	73	19 Mar 36	19,700	53
4 Nov 27	1,000	52	10 Mar 42	2,630	14	4 Nov 27	1,970	39	13 Apr 40	7,000	19
6 Apr 60	740	38	22 Mar 48	2,540	13	13 Apr 40	1,650	33	28 Mar 20	6,020	16

ANNUAL RUNOFF

	Priest Brook Near Winchendon, Mass. c.f.s.	inches	Water Year	Millers River at South Royalston, Mass. c.f.s.	inches	Water Year	East Branch, Tully River Near Athol, Mass. c.f.s.	inches	Water Year	Millers River at Erving, Mass. c.f.s.	inches	Water Year
Mean	32	22.74	(53 Years)	3.04	22.10	(31 Years)	80	21.49	(54 Years)	610	22.18	(56 Years)
Maximum	55	39.86	1928	490	35.63	1960	140	38.10	1928	1,012	37.14	1938
Minimum	8.2	5.73	1965	102	7.39	1965	23	6.18	1965	196	7.08	1965

FLOOD ROUTING COEFFICIENTS

Reach	Routing Coefficient	River Miles Between Points
Birch Hill Dam to Main Street Bridge, Athol, Mass.	3/2 (3 hr)	9.8
Tully Lake to Main Street Bridge, Athol, Mass.	3/1 (3 hr)	5.0
Main Street Bridge, Athol, Mass. to Main Street Bridge, Orange, Mass.	-	5.0
Main Street Bridge, Athol, Mass. to Mouth of Millers River	7/3 (3 hr)	18.6
Mouth of Millers River to Montague City, Mass.	3/1 (6 hr)	7.2

HIGH FLOW TRAVEL TIMES

	Total Hours From Dam Birch Hill Dam	Tully Lake
Main Street Bridge, Athol, Mass.	4-5	2-3
Mouth of Millers River	13-15	11-13
Montague City, Mass.	16-19	14-17

PERTINENT DATA
BIRCH HILL DAM

LOCATION Millers River, Royalston, Massachusetts

DRAINAGE AREA 175 square miles

STORAGE USES Flood Control

RESERVOIR STORAGE

	Elevation (ft msl)	Stage (ft)	Area (acres)	Capacity Acre-Feet	Capacity Inches on Drainage Area
Inlet Elevation	815.0	0	0	0	0
Spillway Crest	852.0	37	3,200	49,900	5.3
Maximum Surcharge	859.0	44	4,000	76,000	8.1
Top of Dam	864.0	49			

EMBANKMENT FEATURES

Type	Rolled earth fill, rock slope protection, impervious core
Length (feet)	1,400
Top Width (feet)	25
Top Elevation (ft msl)	864.0
Maximum Height (feet)	56
Volume (cubic yards)	359,000
Dike	None

SPILLWAY

Location	About 1,900-2,400 feet northwest of the dam
Type	Uncontrolled, ogee weir, chute spillways
Crest Length (feet)	1,190 feet (total) consisting of 810, 350 and 30 foot sections
Crest Elevation (ft msl)	852.0
Maximum Surcharge (ft above crest)	7.0 (elevation 859 feet msl)
Maximum Discharge Capacity (cfs)	56,600

SPILLWAY DESIGN FLOOD

	Original Design 1940	1967 Analysis
Peak Inflow (cfs)	59,000	88,500
Peak Outflow (cfs)	56,600	74,100
Volume Runoff (acre-feet)	193,000	159,500

OUTLET WORKS

Type	4 rectangular conduits, each 6'-0" wide x 12'-0" high
Tunnel Inside	Size 6'-0" wide x 12'-0" high
Tunnel Length (feet)	34
Service Gate Type	Electrically operated gear-driven slide
Size	Four 6'-0" wide x 12'-0" high
Emergency Gate Type	Crane operated slide
Size	One, 6'-0" wide x 12'-0" high
Downstream Channel Capacity (cfs)	2,800
Maximum Discharge Capacity	
Spillway Crest Elevation (cfs)	10,500
Stilling Basin	None

LAND ACQUISITION

Fee Elevation (ft msl)	852
Fee (acres)	4,394
Easement (acres)	253
Clearing Elevation (ft msl)	None

MAXIMUM POOL OF RECORD

Date	8 April 1960
Stage (feet)	25.0
Elevation (ft msl)	840.0
Percent Full	40

UNIT RUNOFF

One Inch Runoff (acre-feet)	9,335

OPERATING TIME

Open/Close All Gates	Each gate at speed of about 1 foot per minute

PROJECT COST (THROUGH FY 71) $4,576,600

DATE OF COMPLETION February 1942

MAINTAINED BY New England Division, Corps of Engineers
Recreation facilities operated and maintained by
Massachusetts Department of Natural Resources

LOCATION East Branch Tully River, Royalston, Massachusetts

DRAINAGE AREA 50 square miles

STORAGE USES Flood Control and Recreation

RESERVOIR STORAGE

	Elevation (ft msl)	Stage (ft)	Area (acres)	Capacity Acre-Feet	Capacity Inches on Drainage Area
Inlet Elevation	625.0	0	0	0	0
Winter Pool	636.0	11	78	525	.2
Recreation Pool	641.0	16	300	1,500	0.6
Spillway Crest	668.0	43	1,130	20,500 (net)	7.7 (net)
Maximum Surcharge	678.8	53.8	1,360	13,800 (net)	5.1 (net)
Top of Dam	684.0	59			

EMBANKMENT FEATURES

Type	Rolled earth fill, rock slope protection, impervious core
Length (feet)	1,570
Top Width (feet)	30
Top Elevation (ft msl)	684.0
Maximum Height (feet)	62
Volume (cubic yards)	185,000
Dike	None

SPILLWAY

Location	About 800 feet southeast of left abutment of dam
Type	Uncontrolled, ogee weir, chute, saddle spillway
Crest Length (feet)	255
Crest Elevation (ft msl)	668.0
Maximum Surcharge (ft above crest)	10.8 (Elevation 678.8 feet msl)
Maximum Discharge Capacity (cfs)	32,700

SPILLWAY DESIGN FLOOD

	Original Design 1944	1967 Analysis
Peak Inflow (cfs)	40,000	47,000
Peak Outflow (cfs)	32,700	39,000
Volume Runoff (acre-feet)	41,900	44,300

OUTLET WORKS

Type	One circular tunnel
Tunnel, Inside Diameter (ft)	6
Tunnel Length (feet)	274
Service Gate Type	Electrically operated gear-driven slide
Size	Two, 3'-6" wide x 6'0" high
Emergency Gate Type	Crane operated slide
Size	One, 4'-0" wide x 10'0" high
Downstream Channel Capacity (cfs)	825
Maximum Discharge Capacity Spillway Crest (cfs)	1,030

RECREATION POOL

Type of Structure	None (pool level controlled by service gates)
Recreation Pool Stage (feet)	16
Area (acres)	300
Shoreline Length (feet)	32,000

LAND ACQUISITION

Fee Elevation (ft msl)	668
Fee (acres)	1,300
Easement Elevation (ft msl)	668
Easement (acres)	4
Clearing Elevation (ft msl)	641

MAXIMUM POOL RECORD

Date	8 April 1960
Stage (feet)	32.3
Elevation (ft msl)	657.3
Percent Full	51

UNIT RUNOFF

One Inch Runoff (acre-feet) 2,665

OPERATING TIME

Open/Close All Gates Each gate at speed of about 1 foot per minute

PROJECT COST (THROUGH FY 71) $1,551,600

DATE OF COMPLETION September 1949

MAINTAINED BY New England Division, Corps of Engineers
Recreation facilities operated and maintained by
Massachusetts Department of Natural Resources

MANUAL OF RESERVOIR REGULATION
MILLERS RIVER WATERSHED
NEW HAMPSHIRE AND MASSACHUSETTS

CHAPTER I

INTRODUCTION

1. REGULATION MANUAL

a. Authorization. This report is prepared pursuant to authority contained in ER 1110-2-240, dated 22 April 1970, Reservoir Regulation) and EM 1110-2-3600, dated 25 May 1959, which requires that manuals of reservoir regulation for flood control, navigation or multipurpose reservoirs be prepared whenever storage allocated to one or more of the functions is the responsibility of the Corps of Engineers. Requirements given in the draft of "A Guide for Preparing Water Control Manuals for Lakes, Reservoirs, Locks and Dams, Hurricane Barriers, Reregulating Structures, Controlled Channels and Floodways, Office, Chief of Engineers," January 1973, were followed in the preparation of this manual.

b. Purpose and scope. This manual will serve as a guide and reference source for higher authority, reservoir regulation and maintenance personnel in the New England Division Office, respective project managers and other personnel who may become concerned with, or responsible for, regulation of the reservoirs in the Millers River watershed. Included in the manual are the following chapters:

(1) Introduction. A brief history of flood problems and studies which led to the authorization of the Millers River watershed flood control projects, including statistical data relative to population, industry and agriculture, and a description of the physical features of all Corps projects.

(2) Management. A general description of the functional responsibilities of the Corps in regard to regulation of the projects, with a listing of all interagency coordinating agreements.

(3) Hydrometeorology. A general description of the watershed and major tributaries, including topographic features and a general coverage of the hydrologic and meteorologic data, i.e., temperature, precipitation, snowfall, snow cover, storms, streamflow and floods.

(4) Communications. A brief description of the means of reporting from field to office such as used by the project managers during non-flood and flood periods, and of the river reporting network and Automatic Hydrologic Radio Reporting System.

(5) Hydrologic Forecasts. A description of all forecasts used by Reservoir Control Center personnel in regulating the projects in the basin, including precipitation forecasts from the National Weather Service, river predictions from the River Forecast Center at Hartford and from the Corps.

(6) Reservoir Regulation. A detailed discussion of the regulation procedures and watershed flood control plan for the two existing flood control dams.

(7) Hydrologic Equipment. A brief resumé of hydrologic equipment used and means of maintaining it.

c. Related manuals. Routine operations and maintenance activities at Birch Hill Dam and Tully Lake are performed by the project managers under the supervision of the Reservoir Branch of the Operations Division which prepared the following manuals.

(1) Birch Hill Dam. Birch Hill Dam, Operation and Maintenance Manual, June 1972, was prepared by the Reservoir Branch of the Operations Division. The manual gives the essential operation and maintenance instructions to operating personnel for the upkeep, repair, maintenance and operation of project facilities.

(2) Tully Lake. Tully Lake, Operation and Maintenance Manual, June 1972, was prepared by the Reservoir Branch of the Operations Division. The manual gives the essential operation and maintenance instructions to operating personnel for the upkeep, repair, maintenance and operation of project facilities.

2. PROJECT DESCRIPTIONS

a. Location. The Millers River watershed (plate F-3) is located in north-central Massachusetts with a small portion extending into southwestern New Hampshire. Plates F-1 and F-2 show the upper and lower Connecticut River basin, respectively.

(1) Birch Hill Dam. The dam is located in Royalston, Massachusetts on the Millers River about 6 miles northeast of Athol,

and about 28.4 river miles above the confluence of the Millers and Connecticut. The reservoir area at spillway crest lies in Worcester County, Massachusetts, in the towns of Winchendon, Templeton and Royalston.

(2) Tully Lake. The dam is also located in Royalston on the East Branch Tully River, about 3 miles north of Athol, and 23.6 river miles above the confluence of the Millers and Connecticut. The reservoir area at spillway crest lies mostly in Royalston with a small portion in Athol.

b. Purpose. Both Birch Hill Dam and Tully Lake are operated to reduce flood stages at Athol, Orange and other communities on the Millers River and, in conjunction with others in the reservoir system to reduce downstream flood stages along the Connecticut River. In addition, water based recreational activities are utilized at both projects.

c. Physical components.

(1) Birch Hill Dam. The important physical components shown on plate F-57 consist of a rolled earth dam with a dumped rock shell, chute spillway composed of three concrete ogee weirs, outlet works and storage for flood control.

The dam embankment, about 1,400 feet in length and maximum height of 56 feet above the streambed, consists of compacted earth fill with an impervious core and rock slope protection and is shown on plate F-6. The top of dam at elevation 864 feet msl provides 7 feet of spillway surcharge and 5 feet of freeboard. The top width of 25 feet accommodates a 20-foot paved access road and the embankment slopes vary from 1 on 2 to 1 on 5.

The spillway consists of three concrete ogee weirs with a total length of 1,190 feet. The main spillway has a length of 810 feet and is located in a natural saddle about 1,900 feet northwest of the dam. One auxiliary spillway, 350 feet in length, is located in a natural saddle and the other, 30 feet long, is located in an abandoned railroad cut about 2,400 feet northwest of the dam. Plan, profile and cross sections of the spillways are shown on plate F-7.

The outlet works at the right abutment of the dam consists of a 1,500-foot long intake channel, a gate structure with a gatehouse

directly above, and an outlet channel 1,150 feet in length. The outlet works are controlled by four 6'-0" x 12'-0" electrically operated slide gates. Plan and sections of the outlet works are shown on plate F-8.

The reservoir, operated for flood control purposes, has a storage capacity of 49,900 acre-feet, equivalent to 5.3 inches of runoff from its drainage area of 175 square miles. When filled to spillway crest, as shown on plate F-4, a 3,200-acre lake would be created with a maximum depth of 37 feet.

A total of 4,394 acres of reservoir land has been acquired in fee; it is comprised of the 82-acre Lake Denison, 200-acre Lake Dennison camping area and 4,112 acres of wild upland forest. The Lake Dennison recreation area, with facilities for boating, fishing, swimming, camping and related outdoor sports is operated and administered by the Massachusetts Department of Natural Resources, Division of Forests and Parks. The remaining reservoir area is managed by the Massachusetts Division of Fisheries and Game for public hunting and fishing.

(2) Tully Lake. The important physical components shown on plate F-58 consist of a rolled earth dam with a dumped rock shell, a chute spillway composed of a concrete ogee weir, outlet works and storage capacity for flood control and recreation.

The dam embankment, about 1,570 feet in length and maximum height of 62 feet above the streambed, consists of compacted earth fill with an impervious core and rock slope protection and is shown on plate F-9. The top of dam at elevation 684 feet msl provides 10.8 feet of spillway surcharge and 5.2 feet of freeboard. The top width of 30 feet accommodates a 20-foot paved access road and the embankment slopes vary from 1 on 2.5 to 1 on 8.

The spillway, consists of a low concrete ogee weir, 255 feet long, which is located in a saddle about 800 feet southeast of the left abutment of the dam. The spillway approach channel is 600 feet in length and the chute-type discharge channel is 1,775 feet long. The plan, profile and cross sections of the spillway are shown on plate F-10.

The outlet works at the east abutment of the dam consist of a 500-foot long intake channel, a gate structure with a gatehouse directly above, a 6-foot inside diameter concrete tunnel 274 feet long through rock and an outlet channel 580 feet in length. The outlet

works are controlled by two 3'-6" x 6'-0" electrically operated slide gates. Plan, profile and cross sections of the outlet works are shown on plate F-11.

The reservoir has a total storage capacity of 22,000 acre-feet, equivalent to 8.3 inches of runoff from its drainage area of 50 square miles. Of this total capacity, 20,500 acre-feet (7.7 inches) is for flood control and 1,500 acre-feet (0.6 inch) for a summer recreation pool. The recreation pool is maintained at a depth of approximately 16 feet, creating a 300-acre pool, which is shown on plate F-5. It is established each spring after snowmelt occurs and held until mid-September when it is drawn down to about an 11-foot stage. At spillway crest a pool with a maximum depth of 43 feet and an area of 1,140 acres would be created. A license has been issued to the Massachusetts Department of Natural Resources for recreation, fish and wildlife and forestry management, and it is expected that the State will operate and administer these facilities by the fall of 1975.

3. HISTORY OF PROJECTS

a. Authorization.

(1) Birch Hill Dam. This dam was authorized by the Flood Control Act approved 22 June 1936 (Public Law No. 738, 74th Congress), as amended by Public Law No. 111, 75th Congress, approved 25 May 1937 and further amended by Public Law No. 761, 75th Congress, approved 28 June 1938.

(2) Tully Lake. This project was authorized by the Flood Control Act approved 22 June 1936 (Public Law No. 738, 74th Congress), as amended by Public Law No. 111, 75th Congress, approved 25 May 1937 and further amended by Public Law No. 761, 75th Congress, approved 28 June 1938. Future power storage was authorized in a letter dated 16 November 1939 to the Secretary of War, where the Federal Power Commission proposed a comprehensive plan for future power development in the Millers River watershed, with Tully Lake as one of the storage sites.

b. Construction.

(1) Birch Hill Dam. Construction was initiated in June 1940, the project became operational in December 1941 and completed in February 1942.

(2) Tully Lake. Construction was initiated in March 1947, the project became operational in January 1949 and completed in September 1949.

c. Other Corps of Engineers project. The Gardner Local Protection Project, shown on plates F-12 thru F-19, primarily provides flood protection to industrial and commercial firms in South Gardner on Greenwood Brook downstream of Wrights Reservoir and on Mahoney Brook downstream of Wayside Pond. The project was authorized by Section 205 of the 1948 Flood Control Act, as amended. Construction was started in August 1964 and completed in October 1965 at a total cost of $528,900. The city of Gardner operates and maintains the project which includes:

(1) Wrights Reservoir. The reconstruction of Wrights Dam, which is the principal element of the project, consists of a 935-foot long dam, 60-foot concrete spillway, 970-foot long dike, a permanent pool which is maintained by a small overflow weir, 27-inch ungated outlet. The spillway crest at elevation 1,070 feet msl is 5.0 feet above the weir crest. Between these two elevations, there are 850 acre-feet of flood control storage, equivalent to 5.1 inches of runoff from the 3.2 square mile drainage area. In the summer months, raising the reservoir level from 1,065 to 1,067 for recreational purposes, reduces the flood control storage to 560 acre-feet or 3.3 inches.

(2) Wayside Pond consists of a control structure with dike (320 feet) and 3 pipe culverts at Wayside Pond.

(3) Mahoney Pond - dikes (680 feet), spillway (45 feet) on Mahoney Pond.

(4) Widening, deepening and realigning critical areas along 700-foot section of Mahoney Brook downstream of Mahoney Pond.

(5) Crib walls on Mahoney Brook at Chelsea Street, Quality Pad Company dam and the South Main Street railroad bridge.

(6) Removal of channel obstructions on Mahoney Brook at Traverse Dam.

d. Modification to authorization.

(1) Birch Hill Dam. There are no modifications to authorized project.

(2) Tully Lake. Tully Lake was originally authorized for flood control only. In May 1964, a request for approval of inclusion of a conservation pool for recreational purposes in the flood control reservoir was made to the Chief of Engineers. This request was the result of a combined planning effort of NED and the Massachusetts Department of Natural Resources. Authorization was granted by a letter from the Chief of Engineers, dated 15 July 1964, with the first pool maintained during the summer of 1966.

The recreation pool is established following the spring snowmelt, usually in April, and maintained until mid-September at elevation 641 feet msl (stage 16 feet). The pool is roughly circular in shape with a diameter of about 4,100 feet, a water surface area of 300 acres, and utilizes 1,500 acre-feet of storage (about 7 percent of the total storage capacity of the reservoir). A winter pool is maintained at elevation 636 feet msl (stage 11 feet) to prevent the flood control gates from freezing.

e. Previous reports. House Document No. 455, 75th Congress, 2d Session, contains a report on survey and comprehensive plan for flood control in the Connecticut River Valley dated 20 March 1937. Birch Hill Dam and Tully Lake were included among the 20 reservoirs of the comprehensive plan, which also recommended dikes at seven cities. The report was prepared by the Corps of Engineers.

A "Review of Reports on Surveys of the Connecticut River and Tributaries for Flood Control," 28 February 1940, revised 18 December 1944, was prepared by the Corps of Engineers. Birch Hill Dam and Tully Lake were included among the 29 reservoirs of the revised comprehensive plan given in this report.

The New England-New York Interagency Committee prepared a report, "The Resources of the New England-New York Region," dated March 1955 and printed in Senate Document 14, 85th Congress, 1st Session. This report recommended a comprehensive flood control plan for the Connecticut River basin consisting of the completed local protection works, the five existing reservoirs which included Birch Hill Dam and Tully Lake, and flood control storage in 21 additional reservoirs none of which were in the Millers River watershed.

The Corps of Engineers' report, "New England Basins, Report on Flood Control and Allied Purposes," 30 June 1955, presented a comprehensive flood control plan for the Connecticut River basin essentially the same as that given in the NENYIAC Report, March 1955.

The Gardner Local Protection Detailed Project Report was submitted 30 November 1962 to the Chief of Engineers for approval under Section 205 of the 1949 Flood Control Act, as amended. It recommended local flood protection for commercial and industrial firms in South Gardner in the Millers River watershed, Massachusetts.

A Flood Plain Information Report, Millers River, Orange-Athol, Massachusetts, authorized under Section 206, Public Law 86-645, was requested by the Commonwealth of Massachusetts. The report, dated June 1965, was prepared by Anderson-Nichols & Company, Inc., Consulting Engineers, Boston, Massachusetts under the direction of NED.

The Comprehensive Water and Related Land Resources Investigation Connecticut River Basin, June 1970, prepared by the Connecticut River Basin Coordinating Committee recommended a basinwide flood control plan and the structural measures consisted of 10 additional Corps of Engineers reservoirs, modification of four existing Corps reservoirs to include other water resource uses, 5 additional local protection projects. Two of these recommendations, namely Gardner Dam and an operational change at Tully Lake, are in the Millers watershed.

Gardner Dam would be located in Gardner on the Otter River about 10.2 miles above its confluence with the Millers River. Its total storage capacity would be 12,300 acre-feet, of which 9,500 acre-feet would be utilized for low flow augmentation for water quality and the remaining 3,000 acre-feet for a permanent conservation pool. However, this recommendation is currently inactive.

An operational change in Tully Lake was proposed to increase the seasonal recreation pool established each spring after the spring runoff and maintained until mid-September. The augmented recreation pool would be maintained at elevation 649 feet msl (stage 24 feet), water surface area of 650 acres and would utilize 5,100 acre-feet of storage (about 23 percent of the total storage capacity of the reservoir) to supplement the water supply for the Metropolitan District Commission of Boston. This proposal is also inactive. Several plans for the diversion of water from the Millers River watershed to Quabbin Reservoir were also considered under the Connecticut Comprehensive Report.

f. Principal project problems.

(1) Birch Hill Dam. In 1966, repairs were made to the eroded intake channel. Repairs consisted of removing, replacing and reshaping

the contractor shall prepare

riprap on the sides of the channel; earth excavation to create a berm on the side slopes of the channel; and moving and installing safety fencing around the top of the slope to the intake channel. This work occurred over about a 550-foot length of channel.

Three of the four service gate stems (#1, 2 and 3) at Birch Hill Dam were damaged on 2 February 1973 in attempting to operate the gates during severe icing conditions. Gate stems #1 and 3 became severely bent while stem #2 was severed. As of this writing, gates 1 and 4 are operational, and the replacement of all three damaged stems is scheduled to begin in May 1974.

On 18 April 1973, approximately 300 cubic yards of rock fell from the left side of the outlet channel about 200 feet downstream of the gatehouse at Birch Hill Dam. This collapse resulted in a partial blockage of the discharge channel. Remedial work, consisting of using the rock to fill a depression located in the outlet channel, approximately 400 feet downstream of the gatehouse, was completed in October 1973.

(2) Tully Lake. In 1969, reservoir clearing to elevation 641 feet msl (stage 16 feet) was accomplished. This is the water surface elevation of the seasonal recreation pool and the clearing removed obstructions to swimming and boating.

The September 1969 inspection by the Corps revealed cavitation in the outlet works tunnel. In the first monolith in the tunnel downstream of the transition section there were about 50 square feet of cavitation varying from 1 to 18 inches in depth. A contract to remove the disintegrated concrete, place anchor bolts and patch the concrete was awarded in June 1972 and completed in August 1972.

g. Current studies. The New England Division, Corps of Engineers, is preparing a survey report for the North Atlantic Division, Corps of Engineers, entitled, "Northeastern United States Water Supply Study." One aspect of the recommended plan would divert water from the Millers River watershed by withdrawals from the East Branch Tully River and the main stem of the Millers River above Athol, Massachusetts. The project would include a morning glory-type inlet structure just downstream of the existing Tully Lake outlet works on the right bank of the discharge channel. Flows into the inlet chamber would be controlled by three 8' x 8' high sluice gates. A 30' x 8' high bascule gate would be located across the discharge channel

immediately downstream of the inlet chamber control gates. Raising and lowering the bascule gate would vary the head, and therefore, the discharge rate into the morning glory spillway. From the spillway flows would travel through an 8' diameter conduit to the Millers River just upstream of Athol and then through a 10-foot diameter conduit to Quabbin Reservoir. The Tully-Millers diversion plan is shown on plate F-20, and the tunnel inlet structure plan and sections are shown on plate F-21. The report is scheduled for completion and submission to OCE by December 1974.

4. ECONOMY OF THE WATERSHED

a. General. The Millers River watershed encompasses several small towns and cities, the largest being Gardner, which registered a population of 19,750 in 1970. The economy of the area has been stable for many years, being built around manufacturing. Several manufacturing industries have been prevalent in this area, primarily furniture and fixtures, metal working machinery and equipment, shoes, sporting goods, toys and wood products.

In Gardner, 48.8 percent of all persons employed in 1970 were engaged in the manufacture of furniture and fixtures. The towns of Templeton and Winchendon also have important furniture manufacturing plants. Manufacturers of metal working machinery and equipment were the leading employers in Athol, the second largest town in the basin. The town of Orange had 50 percent of its work force employed in the production of special industrial machinery. The town of Royalston is primarily an agricultural community with some dairying and fruit growing.

b. Population. In 1970, the population of the watershed was 52,900. This was a growth of only 2.7 percent during the past 10-year period. This rate of growth is considerably less than the national average which is about 1.3 percent per year. Population movements for this area show a constant out-migration with growth due only to the excess of births over deaths. Below is a table showing the population for the major cities and towns in the basin area, all of which are in Massachusetts.

Town or City	1950	1960	1970
Gardner	19,580	19,050	19,750
Athol	11,550	11,640	11,190
Orange	5,900	6,150	6,100
Winchendon	6,590	6,240	6,640
Templeton	4,760	5,370	5,860
Erving	1,320	1,270	1,260
Royalston, Phillipston, Wendell	1,800	1,790	2,090

c. Family income and employment. The median income for families in the State of Massachusetts for 1969 was $11,449. The towns and cities in the Millers basin were lower than that for the State, with Gardner only $9,919 and Athol, the second largest city, $10,015. These figures are 8.5 and 7.6 percent, respectively, below the State level.

The breakdown of employment in the basin area is similar, with 32 percent of them employed as operators and laborers, and 19 percent in the professional and managerial category. Only 8 percent of those employed from each town are in the service industries.

CHAPTER 11

MANAGEMENT

5. GENERAL

a. Project owner. Both Birch Hill Dam and Tully Lake are owned by the Department of the Army, Corps of Engineers.

b. Operating agency. The New England Division is responsible for the operation of both projects. Staffing on a normal work week, Monday through Friday, is 0800 to 1630 hours, and from 0800 to 0900 on Saturday and Sunday, with the project managers living at the site. During flood emergency conditions, the projects will be staffed on a 24-hour basis or as instructed by RCC for the duration of the emergency.

Recreation facilities at Lake Dennison are managed by the Massachusetts Department of Natural Resources, which also holds a lease for future development on the Tully Lake reservoir area.

c. Regulating agency. The New England Division, Corps of Engineers is responsible for the regulation of both projects.

6. FUNCTIONAL RESPONSIBILITIES

a. Corps of Engineers. The reservoir regulation activities of the New England Division are performed by the Reservoir Control Center (RCC), a section of the Water Control Branch. Administrative and maintenance activities at Birch Hill and Tully are performed by the project managers under supervision of the Reservoir Branch of the Operations Division. During regulation periods the managers are responsible to the Reservoir Control Center and report directly to the Center for information and instructions.

The Water Control Branch of the Engineering Division is comprised of three sections; namely, Reservoir Control Center, Hydrologic Engineering, Hydraulics and Water Quality. The RCC consists of a staff of highly trained hydrologic engineers who devote full time to the operation of reservoirs in New England. Members of the other sections not only assist the RCC during routine and flood operations, but also provide technical assistance to the Center as needed. An organization chart for reservoir regulation in the New England Division is shown on plate F-22.

The RCC is divided into basin units, each responsible for receiving routine hydrologic and meteorologic reports and directing reservoir regulation within an assigned river basin. Personnel from RCC and the other sections of the Water Control Branch are assigned to these units. Each unit consists of a regulator in charge of the overall operation in the basin, and project regulators who receive reports and issue instructions to individual dams either from NED headquarters during working hours or from their homes during nonworking hours. Whenever severe emergency conditions exist, the RCC staffs NED headquarters and regulation units are organized to assure 24-hour operations as long as necessary.

b. Other agencies. There are no other Federal, State, county or private agencies that have any responsibility in regulating the flood control aspect of either Birch Hill Dam or Tully Lake.

7. INTER-AGENCY COORDINATION

a. Inter-Agency agreements. The Corps of Engineers has cooperative working programs with the U.S. Geological Survey, the National Weather Service and its River Forecast Center at Hartford, Connecticut. The Corps uses the hydrologic and forecasting information from these agencies in operating its flood control reservoirs in a manner to provide efficient protection for downstream communities.

b. Compacts. Congress, by the passage of Public Law 52, 83d Congress, 6 June 1953, granted its consent and approval to an interstate compact, covering the Connecticut River Valley, that had been previously ratified by the States of New Hampshire, Vermont, Massachusetts and Connecticut. The principal purposes of the compact are:

(1) Assuring adequate storage capacity for impounding waters of the basin in the interest of flood control. Five dams, Union Village, Surry Mountain, Knightville, Tully and Birch Hill were in operation at the time the compact was instituted. These dams were endorsed by the compact and included in the tax sharing clause. Twelve additional locations were agreed upon for future tax reimbursement if they were constructed.

(2) A system of tax loss reimbursement was set up so that the southern Connecticut River Basin states would share the tax loss with the northern states from Federal acquisition of lands for any flood control dam and reservoir built in the Connecticut River Valley. A tabulation of this tax reimbursement is listed on the following page.

Recipient State	Percent Tax Loss Reimbursed	Reimbursing State
Vermont	40	Connecticut
Vermont	50	Massachusetts
New Hampshire	40	Connecticut
New Hampshire	50	Massachusetts
Massachusetts	40	Connecticut

(3) Providing a joint or common agency through which the signatory states may effectively cooperate in accomplishing the objectives of flood control and water resources utilization in the basin.

The compact also provides for creation of a commission consisting of three representatives from each of the four states with authority to enter into contracts and agreements and to make such ongoing studies and investigations as may be required in the interest of flood control and in cooperation with Federal agencies.

c. News releases. It is the policy of the Corps of Engineers to cooperate with the local press and all other forms of news media. This cooperation provides the local community with information regarding the regulation of the Millers River projects.

The primary source of information regarding the regulation of the projects is the Public Affairs Officer who is responsible for issuing all communiqués to the press and news media.

Whenever project managers receive requests for information from local news media and private citizens, the operator can give out information pertinent to his project. However, the operator will not make any flood forecasts. Referrals should be made to RCC for additional information.

CHAPTER III

HYDROMETEOROLOGY

8. DESCRIPTION OF WATERSHED

The Millers River watershed, located in north-central Massachusetts with a small section in southwestern New Hampshire, has a length of about 33 miles and a maximum width of about 19 miles. The total 392 square mile drainage area includes 320 in Massachusetts and 72 in New Hampshire. Generally, the watershed is hilly with low mountains in the headwaters with many natural ponds and lakes scattered throughout the area. Elevations vary from peaks of 1,880 feet on the northern and eastern divides to 180 feet near the mouth of the Millers River.

The Millers has its confluence with the Connecticut River in Massachusetts, 126.2 river miles from the mouth of the Connecticut, 13.6 river miles downstream of the Ashuelot and 7.0 river miles upstream of the Deerfield River. Its source is in Ashburnham, Massachusetts at Lower Naukeag Lake and it flows in a general westerly direction for about 45 miles through Winchendon, Athol and Orange to its confluence with the Connecticut River. The upper reaches of the river are fed by a number of small brooks flowing in a southerly direction from the towns of Rindge and New Ipswich, New Hampshire. The Millers River has a total fall of approximately 900 feet. Just upstream of Birch Hill Dam there is a fairly flat gradient of the river for a distance of 6 miles with a fall of about 15 feet. The only relatively flat gradient of the Millers River downstream of Birch Hill Dam lies between the Main Street bridges in Athol and Orange, a distance of 5 miles with a fall of about 5 feet. A watershed map and profile are shown on plates F-3 and F-23, respectively.

The principal tributaries of the Millers River are the Otter and Tully Rivers, with respective drainage areas of 60 and 74 square miles.

The Otter River has its source in Templeton, Massachusetts. It flows in a meandering northwesterly direction for a distance of almost 4 miles forming the boundary line between the town of Templeton and the city of Gardner, then continuing through the town of Baldwinville and the Birch Hill reservoir area to its confluence with the Millers River. The river falls about 100 feet in its length of 12.7 miles.

The Tully River, formed by the confluence of its East and West Branches, flows southerly 1.4 miles with a fall of about 5 feet, to its juncture with the Millers River. The East Branch, with a total length of 9.7 miles and a fall of about 160 feet, begins at the confluence of Tully Brook (New Hampshire) and Falls Brook and flows in a general southerly direction through the Tully reservoir area to join the West Branch. The West Branch rises in Warwick, Massachusetts, flows in a southeasterly direction through Sheomet Lake, and continues in a southeasterly direction to join the East Branch. It has a length of 9.5 miles with a fall of about 670 feet.

9. CLIMATE AND RUNOFF

a. Precipitation. The mean annual precipitation over the watershed is about 41 inches, distributed fairly uniformly throughout the year. Average monthly precipitation at Winchendon, Massachusetts varies from a minimum of 2.91 inches in February to a maximum of 3.87 inches in July. Extremes in monthly precipitation at Winchendon vary from a minimum of 0.05 inches in March and October to a maximum of 15.89 inches in September. Monthly precipitation records for four stations in or near the watershed are listed in table F-1. The annual precipitation records for the same stations are shown on plate F-24.

b. Temperature. The average annual temperature is about 47° Fahrenheit (F). Average monthly temperatures vary widely throughout the year. At Turners Falls, Massachusetts, temperatures vary from about 23° in January to about 72° in July. Extremes range from a low of -30° in February to a high of 104° in July. Table F-2 lists the mean monthly and the absolute maximum and minimum temperatures at three stations in the watershed.

c. Snow and snow cover. The mean annual snowfall is about 59 inches with about 50 percent of this amount occurring in January and February. The variations of the average monthly snowfall at four locations are given in table F-3. Snow surveys have been taken in the watershed by the Corps since December 1948. The locations of these snow courses are shown on plate F-3 and pertinent data regarding them are contained in table F-4. Water content in the snow cover reaches a maximum about the middle of March and from 1950 to date has averaged about 3.4 inches, with a maximum of 7.7 inches and a minimum of no snow.

d. Storms. The three general types of storms occurring in the Millers River watershed are continental, coastal and those associated

TABLE F-1

MONTHLY PRECIPITATION
MILLERS RIVER WATERSHED
(Depth in Inches)

Month	Winchendon, Mass. Elevation 1020 feet msl 77 Years of Record Through 1970			Birch Hill Dam, Royalston, Mass. Elevation 840 feet msl 22 Years of Record Through 1970		
	Mean	Maximum	Minimum	Mean	Maximum	Minimum
January	3.21	7.20	0.78	2.91	5.95	0.78
February	2.91	6.19	0.68	2.75	5.12	0.88
March	3.48	8.52	0.05	3.00	6.49	0.85
April	3.38	6.85	0.72	3.17	5.04	0.77
May	3.35	7.24	0.75	3.07	6.67	0.93
June	3.85	12.00	0.83	3.29	7.64	0.59
July	3.87	10.25	0.98	2.95	6.86	0.79
August	3.62	8.64	0.44	3.29	10.44	0.80
September	3.86	15.89	0.32	3.02	7.73	0.64
October	3.05	8.42	0.05	2.78	7.07	0.47
November	3.66	8.31	0.79	3.87	7.06	1.32
December	3.45	9.80	0.58	3.42	5.99	0.76
ANNUAL	41.69	59.98	28.26	37.52	50.49	25.91

Month	Tully Lake, Royalston, Mass. Elevation 685 feet msl 21 Years of Record Through 1970			Turners Falls, Mass. Elevation 190 feet msl 71 Years of Record Through 1970		
	Mean	Maximum	Minimum	Mean	Maximum	Minimum
January	2.97	6.44	0.72	3.20	6.63	0.69
February	2.95	5.18	0.99	2.75	6.22	0.51
March	3.26	6.99	1.23	3.35	8.10	0.22
April	3.54	5.30	1.04	3.30	6.04	0.57
May	3.42	7.21	1.34	3.56	7.77	0.44
June	3.71	8.63	0.77	3.49	8.04	0.67
July	3.40	6.68	0.86	3.70	15.39	0.84
August	3.47	10.70	0.95	3.61	12.11	0.65
September	3.29	7.75	0.79	3.60	12.94	0.39
October	3.27	10.62	0.53	2.84	8.55	0.00
November	4.12	8.29	1.91	3.66	7.89	0.66
December	3.67	7.15	0.84	3.26	7.92	0.40
ANNUAL	41.07	54.28	27.67	40.32	55.18	27.66

TABLE F-2

TEMPERATURE
MILLERS RIVER WATERSHED
(Degrees Fahrenheit)

Month	BIRCH HILL DAM, ROYALSTON, MASS. 22 Years of Record Through 1970			TULLY LAKE, ROYALSTON, MASS. 21 Years of Record Through 1970			TURNERS FALLS, MASS. 74 Years of Record Through 1970		
	Mean	Absolute Maximum Recorded	Absolute Minimum Recorded	Mean	Absolute Maximum Recorded	Absolute Minimum Recorded	Mean	Absolute Maximum Recorded	Absolute Minimum Recorded
January	22.1	62	-34	20.6	62	-29	23.4	66	-27
February	24.0	64	-25	22.5	64	-27	24.3	65	-30
March	32.1	73	-18	31.7	75	-19	34.4	85	-21
April	44.9	88	6	44.5	92	6	46.2	91	4
May	55.3	92	20	54.8	96	22	57.9	96	24
June	64.6	97	29	64.4	98	30	66.9	103	31
July	68.8	96	36	68.9	100	37	71.7	104	36
August	66.6	99	30	66.6	99	30	69.3	103	34
September	59.2	98	20	58.8	100	22	62.1	99	25
October	49.5	85	13	48.5	87	16	51.3	92	18
November	38.6	79	3	37.9	80	4	39.5	82	0
December	25.9	62	-25	24.7	62	-21	27.2	66	-24
ANNUAL	46.0	99	-34	45.3	100	-29	47.9	104	-30

MONTHLY SNOWFALL
MILLERS RIVER WATERSHED
(Depth in Inches)

Month	WINCHENDON, MASS. 26 Years of Record Through 1960 Mean	Percent of Annual	BIRCH HILL DAM ROYALSTON, MASS. 22 Years of Record Through 1970 Mean	Percent of Annual
January	15.6	26.5	15.2	22.4
February	14.4	24.5	18.0	26.5
March	11.7	19.9	14.5	21.4
April	3.0	5.1	2.5	3.7
May	0.1	0.2	0.2	0.3
June	0.0	0.0	0.0	0.0
July	0.0	0.0	0.0	0.0
August	0.0	0.0	0.0	0.0
September	0.0	0.0	0.0	0.0
October	0.1	0.2	0.3	0.4
November	3.5	5.9	3.1	4.5
December	10.4	17.7	14.1	20.8
ANNUAL	58.8	100.0	67.9	100.0

Month	TULLY LAKE ROYALSTON, MASS. 21 Years of Record Through 1970 Mean	Percent of Annual	TURNERS FALLS, MASS. 64 Years of Record Through 1963 Mean	Percent of Annual
January	14.5	23.5	15.6	28.3
February	16.7	27.1	15.2	27.6
March	13.1	21.2	9.1	16.5
April	1.6	2.6	2.1	3.8
May	Trace	0.0	Trace	0.0
June	0.0	0.0	0.0	0.0
July	0.0	0.0	0.0	0.0
August	0.0	0.0	0.0	0.0
September	0.0	0.0	0.0	0.0
October	Trace	0.0	Trace	0.0
November	2.8	4.6	2.7	4.9
December	12.9	21.0	10.4	18.9
ANNUAL	61.6	100.0	55.1	100.0

TABLE F-4

CORPS OF ENGINEERS
SNOW COURSE LOCATIONS
MILLERS RIVER WATERSHED

Course	Elevation (ft. msl)	Latitude	Longitude	Period of Record
Ashburnham, Mass.	1,160	42°-38'-30"	71°-56'-00"	Dec 1948-To Date
Otter River, Mass.	970	42°-32'-45"	72°-00'-30"	Dec 1948-To Date
Rindge, N.H.	1,260	42°-44'-45"	72°-00'-30"	Dec 1948-To Date
Pequoig, Mass.	1,010	42°-39'-50"	72°-00'-35"	Dec 1948-To Date
Birch Hill Dam, Mass.	800	42°-37'-45"	72°-07'-30"	Dec 1948-To Date
Fitzwilliam, N.H.	1,090	42°-46'-50"	72°-07'-45"	Dec 1948-To Date
South Royalston, Mass.	1,110	42°-38'-35"	72°-09'-20"	Dec 1948-To Date
Tully Dam, Mass.	700	42°-38'-45"	72°-13'-40"	Dec 1948-To Date
Richmond, Mass.	1,200	42°-43'-20"	72°-15'-50"	Dec 1948-To Date

with thunderstorms which may be of local origin or the result of a stationary front. Continental storms originate over the western or central part of the United States and move in a general easterly and northeasterly direction. These storms may be rapidly moving intense cyclones or of the stationary type. They are not limited to any season or month, but follow one another at more or less regular intervals with varying intensities throughout the year.

Tropical hurricanes are the most important of the coastal storms. They originate either in the South Atlantic or in the Western Caribbean Sea and generally move in a westerly or northwesterly direction, recurving to the north as they near the mainland, and then to the northeast approaching New England. In general, hurricanes are likely to occur during the months of July through October with greater incidence in the months of August and September.

Coastal storms of an extratropical nature differ from the hurricanes principally as they originate along the eastern seaboard and have less energy associated with them. These storms travel northward along the coast, occurring most frequently during the autumn, winter and spring months. Thunderstorms may be of local origin or the frontal type associated with the summer months.

e. Runoff.

(1) Discharge records. There are nine USGS gaging stations in the watershed (locations are shown on plate F-3). The period of record for these stations is listed on page i. A computed daily hydrograph for the Millers River at Birch Hill Dam (1916-1939) is shown on plate F-25, while an observed daily hydrograph for East Branch Tully River (1916-1943) is shown on plates F-26 and F-27.

(2) Streamflow data. The average annual runoff for the 56-year period of record through September 1970 on the Millers River at Erving is 22.18 inches with a maximum of 37.14 inches in water year 1938 and a minimum of 7.08 inches in water year 1965. The mean annual runoff represents about 55 percent of the mean annual precipitation and about 50 percent of this runoff occurs in the spring months of March, April and May. Discharges for the period of record have varied from a maximum of 29,000 cfs on 22 September 1938 to a minimum of practically no flow. The minimum average daily flow was 8 cfs on 6 September 1926 and the average annual flow is 610 cfs, adjusted for change in contents in Birch Hill and Tully reservoirs.

TABLE F-5

MONTHLY RUNOFF
MILLERS RIVER WATERSHED

Month	PRIEST BROOK NEAR WINCHENDON, MASS. (DA = 19.4 SQ. MI.) 1916-1970						MILLERS RIVER AT SOUTH ROYALSTON, MAS (DA = 187 SQ. MI.) 1940-1970			
	Average		Maximum		Minimum		Average		Maximum	
	CFS	Inches	CFS	Inches	CFS	Inches	CFS	Inches	CFS	Inches
January	28.3	1.70	79.0	4.69	1.23	0.07	283	1.74	697	4.29
February	24.1	1.32	81.7	4.39	5.30	0.29	287	1.61	773	4.30
March	75.9	3.78	199.0	12.22	13.6	0.81	531	3.27	1,043	6.43
April	96.3	5.60	225.0	12.95	27.6	1.64	824	4.92	1,850	11.04
May	43.1	2.59	91.9	5.46	12.8	0.76	435	2.68	871	5.37
June	26.6	1.45	107.0	6.35	2.5	0.15	253	1.51	631	3.77
July	11.9	0.71	62.5	3.83	1.04	0.06	120	0.74	369	2.27
August	10.0	0.60	68.8	4.22	0.47	0.03	96	0.60	332	2.05
September	13.2	0.70	178.0	10.57	0.29	0.02	115	0.68	551	3.29
October	13.1	0.79	62.4	3.71	0.55	0.03	159	0.98	802	4.94
November	27.1	1.61	124.0	7.36	1.38	0.08	271	1.62	854	5.10
December	31.4	1.89	94.7	5.81	4.67	0.29	284	1.75	643	3.96
Water Year	32.1	22.74	55.0	39.86	8.19	5.73	304	22.10	490	35.63

Month	EAST BRANCH TULLY RIVER NEAR ATHOL, MASS. (1) (DA = 50.4 SQ. MI.) 1916-1970						MILLERS RIVER AT ERVING, MASS. (1 (DA = 375 SQ. MI.) 1914-1970			
	Average		Maximum		Minimum		Average		Maximum	
	CFS	Inches	CFS	Inches	CFS	Inches	CFS	Inches	CFS	Inches
January	72	1.66	186	4.30	10	0.23	574	1.77	1,331	4.09
February	65	1.35	171	3.54	14	0.30	547	1.54	1,494	4.15
March	158	3.63	525	12.11	42	0.97	1,133	3.50	3,989	12.45
April	227	5.04	528	11.70	80	1.77	1,590	4.75	3,584	10.66
May	111	2.54	247	5.66	41	0.95	823	2.54	1,650	5.07
June	62	1.38	244	5.42	7	0.15	509	1.52	1,640	4.92
July	30	0.68	153	3.52	4	0.09	298	0.92	1,118	3.48
August	26	0.54	188	4.32	1	0.02	234	0.72	1,050	3.25
September	29	0.64	388	8.68	1	0.01	277	0.83	3,031	9.14
October	30	0.70	121	2.78	1	0.03	279	0.86	1,292	3.97
November	69	1.52	269	5.98	4	0.08	482	1.44	1,620	4.85
December	79	1.81	239	5.49	13	0.30	578	1.79	1,540	4.78
Water Year	80	21.49	140	38.10	23	6.18	610	22.18	1,012	37.14

(1) Runoff adjusted for change in contents in reservoir storage at Birch Hill Dam and/or Tully Lake.

A summary of the maximum, minimum and average monthly and the average annual runoff for four selected USGS gaging stations are shown on table F-5. The annual runoff values for each of these stations are listed on plate F-28. A summary of runoff data for the four stations is shown on the pertinent data sheet of hydrologic information. Rating tables for the USGS gage at Montague City, Erving, South Royalston and East Branch Tully River are shown on plates F-29 through F-33.

f. Frequency analysis.

(1) Peak discharge frequency. The natural frequency of occurrence of discharges was determined for selected U.S. Geological Survey gaging stations in the Millers River watershed and is shown in table F-6. Frequency analyses were made in accordance with procedures in ER 1110-2-1450, "Hydrologic Frequency Estimates," dated 10 October 1962. Following a regional frequency analysis, a skew coefficient of 1.0 was adopted for all tributaries of the Connecticut River.

TABLE F-6

NATURAL PEAK DISCHARGE FREQUENCY DATA
(cfs)

Expected Probability Percent Chance	Recurrence Interval Years	Millers R. at Erving	Millers R. near Winchendon	East Branch Tully River near Athol
0.50	200	26,000	7,200	5,900
1.0	100	20,200	5,700	4,400
2.0	50	15,900	4,400	3,300
5.0	20	11,000	3,000	2,300
10.0	10	8,500	2,300	1,600
20.0	5	6,500	1,800	1,200
50.0	2	4,400	1,200	700
99.0	1	3,200	1,000	400

(2) Frequency of reservoir filling. The pool stage at Birch Hill Dam has equalled or exceeded 10 feet, which is about 7 percent of total flood control storage capacity, 36 times from the beginning of operations in December 1941 through December 1973.

The pool stage at Tully Lake has equalled or exceeded 18 feet, which is about 7 percent of total flood control storage capacity, 25 times from the beginning of operations in January 1949 through December 1973. A tabulation of these operations, with the amount of floodwaters stored, is given in tables F-7 and F-8. The area-capacity table and area-capacity and percent full curves are shown on plates F-34, F-35 and F-36 for Birch Hill Dam and on plates F-37, F-38 and F-39 for Tully Lake.

10. CHANNEL AND FLOODWAY

The non-growing season safe channel capacity just downstream of Birch Hill Dam on the Millers River is approximately 2,800 cfs and just below Tully Lake on the East Branch of the Tully River, about 800 cfs, during the growing season these values drop to about 2,000 and 650 cfs, respectively.

Principal damage centers in the watershed during past floods have been at Athol and Orange, both important manufacturing centers. The most important Millers River index station is the staff gage at the Main Street bridge in Athol (280 square miles). Another index staff gage is located in Orange just upstream of the Main Street bridge (316 square miles).

Regulation to protect Athol, with its relatively small channel capacity of 3,100 cfs (11 csm), will also maintain flows well within banks in Orange and all other downstream locations on the Millers River.

A large agricultural field just upstream of the Main Street bridge in Athol is flooded nearly every spring. Regulation procedures should try and prevent the cornfield from being flooded during the summer growing season.

Releases from Birch Hill Dam and Tully Lake, up to channel capacities just below these dams, should be made once a year, conditions permitting, such as reservoir inflows and river stage in Athol.

11. FLOODS OF RECORD

a. General. Flooding in the Millers River watershed can occur at any time of the year. The floods of November 1927 and September 1938 were caused by heavy rainfall, while the events of March 1936 and April 1960 were caused by heavy rainfall, warm weather and considerable snowmelt.

TABLE F-7

SIGNIFICANT RESERVOIR OPERATIONS AT BIRCH HILL DAM
DECEMBER 1941-DECEMBER 1973

Date	Maximum Stage (feet)	Total Reservoir Storage Utilized	
		Acre-Feet	Percent Total
1943 13 Nov	12.0	4,550	9
1944 26 Jun	14.0	6,150	12
1947 5 Feb	12.8	5,190	10
1948 25 Mar	20.2	12,680	25
1949 7 Jan	12.3	4,790	10
1950 28 Nov	11.5	4,225	8
1951 5 Apr	15.0	6,950	14
1952 9 Apr	11.0	3,900	8
1953 31 Mar	19.0	11,150	22
1954 20 Apr	12.6	5,030	10
1954 13 Sep	11.1	3,965	8
1955 22 Aug	13.7	5,910	12
1955 19 Oct	19.8	12,150	24
1955 7 Nov	12.0	4,550	9
1956 13 Jan	16.7	8,515	17
1956 2 May	18.8	10,910	22
1958 21 Apr	13.5	5,750	12
1959 5 Apr	14.2	6,310	13
1959 26 Oct	11.9	4,485	9
1959 30 Nov	11.5	4,225	8
1960 8 Apr	25.0	20,400	41
1960 14 Sep	11.2	4,030	8
1962 3 Apr	17.4	9,260	19
1963 7 Apr	15.1	7,040	14
1964 17 Apr	11.8	4,420	9
1967 20 Apr	11.1	3,965	8
1967 28 May	11.3	4,095	8
1968 25 Mar	21.2	13,900	28
1969 24 Apr	22.5	16,100	32
1970 6 Apr	11.0	3,900	8
1972 22 Apr	13.5	5,750	12
1973 5 Feb	12.3	4,790	10
1973 19 Mar	10.6	3,560	8
1973 4 Apr	10.7	3,620	8
1973 3 Jul	15.0	6,900	14
1973 24 Dec	17.2	9,020	18

Note: No winter pool maintained.

TABLE F-8

SIGNIFICANT RESERVOIR OPERATIONS AT TULLY LAKE
JANUARY 1949-DECEMBER 1973

Date	Maximum Stage (feet)	Flood Control Storage Utilized	
		Acre-Feet	Percent
1951 6 Apr	21.3	3,050	14
1953 27 Jan	18.9	1,900	9
1953 31 Mar	24.7	4,920	23
1956 14 Jan	18.4	1,680	8
1956 5 May	26.1	5,770	27
1959 5 Apr	18.2	1,590	7
1959 27 Oct	20.0	2,400	11
1959 30 Nov	18.8	1,860	9
1960 9 Apr	32.3	10,670	50
1962 9 Apr	21.8	3,300	15
1963 7 Apr	20.5	2,650	12
1964 29 Jan	19.0	1,950	9
1964 18 Apr	20.0	2,400	11
1966 28 Mar	19.4	2,130	10
1967 21 Apr	19.3	2,080	10
1967 29 May	22.4	3,620	17
1968 26 Mar	24.7	4,920	23
1969 25 Apr	24.2	4,620	22
1969 9 Nov	19.5	2,180	10
1970 10 Apr	20.3	2,550	12
----------	----------	----------	(See note below)
1972 24 Apr	23.6	4,280	20
1973 6 Feb	19.5	2,180	10
1973 19 Mar	20.0	2,400	11
1973 3 Jul	18.7	2,500	9
1973 24 Dec	21.3	3,050	14

Notes: A winter pool with a 10 to 12 foot stage is maintained.

In May 1971, a 16-foot stage recreation pool was established with 1,500 acre-feet of storage which is equal to 7 percent of total storage capacity.

b. Historic floods. The flood history of the Millers River watershed extends back to the first settlers, about 300 years. Information regarding a number of the most severe floods in this area was obtained through field investigations and research of published U.S. Geological Survey data and newspaper accounts. Following is a list of known historic floods:

Year	Month	Year	Month
1801	March	1869	October
1824	February	1878	December
1841	January	1887	July
1843	March	1895	April
1846	March	1896	March
1854	May	1900	February
1862	April		

The order of magnitude of these floods is not known; however, they were all smaller than the September 1938 flood, which is the maximum of record.

c. Recent floods. In recent years, four significant floods have been experienced in the Millers River watershed. These floods occurred in November 1927, March 1936, September 1938 and April 1960. Flood information for these events at selected locations in the watershed are given on page i.

(1) November 1927 flood. A tropical storm formed over the Caribbean late in October 1927, started northward 1 November and was at the lower end of Chesapeake Bay by 3 November. The storm followed a path over western Massachusetts and Vermont, and caused the greatest flooding on the Vermont tributaries of the Connecticut River, with serious flooding in New Hampshire and the western tributaries of Massachusetts. Storm rainfall, 2-4 November, at Fitchburg, Winchendon and Turners Falls, Massachusetts was 5.3, 4.0 and 4.5 inches, respectively. The 24-hour rainfall at these three stations was 5.1, 3.6 and 3.5 inches, respectively. Peak flows during this storm at Priest Brook near Winchendon, East Branch Tully River near Athol and Millers River at Erving were 56, 39 and 17 cfs per square mile of drainage area (csm), respectively. The total volume of runoff at the Erving gage for the period 3-10 November was 2.4 inches.

(2) March 1936 flood. After the first week of March 1936, temperatures in New England became unseasonably warm and continued

so for the remainder of the month. The snow cover in the upper and central parts of the Connecticut River basin was above average as little thawing had occurred in January and February. During the period 9-22 March, three storm centers passed over New England, with heavy rainfall on 11-12 and on 17-18 March. The total storm rainfall at Fitchburg, Winchendon and Turners Falls was 9.17, 6.6 and 5.9 inches, respectively. The water equivalent of the snowmelt during this period was estimated at about 5 inches. Peak flows during this storm at Priest Brook near Winchendon, East Branch Tully River near Athol and Millers River at Erving were 95, 73 and 53 csm, respectively. Approximately 12 inches of runoff occurred in the basin during the last three weeks of March. At the Main Street bridge in Athol, the Millers River reached a peak elevation equivalent to 15.9 feet on the present staff gage. The Connecticut River at Hartford crested at 37.6 feet, which is the greatest flood in over 300 years of record. On the Connecticut River, from the vicinity of Fifteenmile Falls to its mouth, all previously known flood discharges were exceeded except in that part of the river just downstream of White River Junction, Vermont where the peak was less than that of the November 1927 flood. Plate F-40 shows the natural flood hydrograph and the hydrograph as modified by both reservoirs at the Main Street staff gage and at the Millers River gage at Erving, Massachusetts.

(3) September 1938 flood. The flood of record in the Millers River watershed occurred in September 1938, when after a week of antecedent rainfall, a major hurricane traveled northward through the Connecticut River valley on 21 September. Storm rainfall, 17-21 September, at Fitchburg, Winchendon and Turners Falls was 8.6, 13.0 and 10.7 inches, respectively. Peak flows during this storm at the Millers River near Winchendon, Priest Brook near Winchendon, East Branch Tully River near Athol and Millers River at Erving were 102, 155, 102 and 78 csm. In the period 20-25 September, more than 7 inches of runoff occurred throughout the basin. This was the second largest flood on the lower Connecticut River and the greatest of record on many tributaries in the central and lower portions of the basin. At the Main Street bridge in Athol the river reached a peak stage of 20.8 feet on the staff gage. The flood crested at 35.4 feet at Hartford, which was the second highest of record. Plate F-41 shows the natural flood hydrograph and the hydrograph as modified by both reservoirs at the Main Street gage in Athol and at the Millers River gage at Erving, Massachusetts.

(4) April 1960 flood. At the end of March 1960 there was heavy snow cover in the headwater areas of the major river basins in New England due to heavy March snowfall and unusually cold temperatures.

Warm weather, moderate rainfall and melting snow occurred from 30 March to 6 April. On 4-6 April, rainfall at Fitchburg, Winchendon and Turners Falls was 1.8, 2.2 and 2.5 inches, respectively. These hydrologic conditions resulted in basinwide flood conditions and Birch Hill Dam and Tully Lake reached 40 and 51 percent of their respective flood control storage capacities. Stages on the Connecticut River were the highest in Connecticut since 1955 and among the highest from Massachusetts northward since 1938.

12. ANALYSIS OF FLOODS

a. Millers River. Floodflows and precipitation records were analyzed to determine the runoff characteristics of the Millers River watershed such as: time of year when floods may occur, effect of topography, relative timing and flood peak contributions at downstream damage centers on the Millers and Connecticut Rivers. The analysis resulted in the following conclusions:

(1) The Millers River watershed responds quickly to periods of intense rainfall which may occur in any month and as a result, there is no flood-free season of the year.

(2) The spring snowmelt is not of damaging magnitude unless augmented by rainfall.

(3) Although there are a number of moderate to steep slopes throughout the basin, a large number of lakes, ponds and swampy areas result in runoff characteristics that are considered moderate.

The principal flood-producing tributaries in the watershed are the Otter and Tully Rivers. Larger brooks feeding directly into the Millers River, such as Tarbell, Priest, Lake Rohunta, Orcutt and Moss, also contribute to floods. Many lakes and ponds scattered throughout the watershed add significant amounts of natural storage. Approximate high flow travel times and flood routing coefficients for reaches of the Millers River are shown on page i.

b. Connecticut River. Flooding along the Connecticut River is caused by excessive rainfall, melting snow or a combination of both. Analyses of floods of record reveal that Connecticut River floods have generally originated in one of the following manners: (1) as a general basinwide flood, usually with snowmelt, (2) in the northern portion upstream of White River Junction, (3) in the central portion between White River Junction and Montague City, and (4) in the southern portion downstream of Montague City. The November 1927 event occurred in the

central and upper portions of the basin, the March 1936 flood was basin-wide, the September 1938 flood originated in the lower and central portions of the basin, the flood of August 1955 was a lower basin event, and the April 1960 event was caused by considerable rainfall and snowmelt throughout the basin.

c. Ice jam flooding. During the spring runoff period consideration should be given to possible ice jam flooding in the vicinity of the Athol Manufacturing Company, Union Twist Drill Company and Starrett Company dams, Main Street bridge and the Daniel Shays Highway (U.S. Route 202) bridge in Athol. These locations have not experienced any major flooding due to ice jams in recent years. However, minor flooding may be expected during the annual spring runoff.

13. DESIGN FLOODS

a. Spillway design flood.

(1) Birch Hill design criteria. As presented in the "Analysis of Design," 1940, a maximum predicted storm in the Birch Hill watershed, based on a New England rainfall study, was developed by the National Weather Service in conjunction with OCE. The computed spillway flood was determined by applying the unit hydrograph, derived from the composite September 1938 flood of record, to the maximum predicted storm.

The most severe possible conditions were assumed in the derivation of the computed spillway flood and a factor of safety of 1.35 applied to determine the spillway design flood. The ordinates of discharge of the computed spillway flood hydrograph were increased by 1.35 without changing the storm duration. Thus, peak discharge and volume were increased 35 percent while the storm period remained unchanged.

Total spillway design storm rainfall, 24-hour duration, was 22.28 inches (infiltration - 1.20 inches and rainfall excess - 21.08 inches). The reservoir inflow and outflow peaks were 59,000 and 56,600 cfs, respectively, for the spillway design flood.

Spillway design requirements included: pool at spillway crest at start of spillway design flood, gates closed during entire flood period and maximum wave heights occurring at time of maximum spillway discharge.

(2) Birch Hill 1974 criteria. Pursuant to the authority contained in Public Law 91-611, 91st Congress, Section 216, dated

31 December 1970, a review is being made of the spillway design and real estate acquisitions at selected older dams and lakes in the New England Division to determine whether they conform adequately with current policies and criteria with respect to safety and functional reliability. The report on Birch Hill was completed in March 1974, including a determination of the adequacy of spillway discharge capacities and freeboard allowances. A summary of original and 1974 hydrologic design criteria for Birch Hill Dam is given in table F-9. The maximum surcharge elevation, as computed according to the 1974 criteria, is 1.4 feet lower than that given by the original and design criteria and therefore meets the safety requirements for freeboard needs.

(3) Tully design criteria. The "Revised Analysis of Design," October 1944, presents the design criteria for Tully Lake. The computed spillway flood is based on Engineer Bulletin No. 9 which defines it as "the flood computed by means of the forecast worst storm, the highest runoff factors and the worst runoff-producing combinations for the drainage area in question." The forecast worst storm is that which will occur without snow cover. It will produce higher rates of flood discharge than the maximum rainfall combined with snowmelt. This was confirmed by computation. The forecast worst storm, 36-hour duration, as determined from Hydrometeorological Report No. 1, has a total rainfall of 19.1 inches (infiltration - 1.5 inches and rainfall excess - 17.6 inches). The computed spillway flood was determined by applying the adopted unit hydrographs to the rainfall excess of the maximum possible storm without snow cover and adding a base flow of 100 cfs.

The spillway design flood was established by increasing the peak rate of discharge of the computed spillway flood by 50 percent (as a factor of safety) with volume unchanged.

The reservoir inflow hydrograph was obtained by reverse-routing the spillway design flood at the damsite through valley storage in the reservoir below the spillway crest. The peak inflow is 40,000 cfs.

Spillway design requirements included: reservoir filled to spillway crest at start of spillway design flood, gates closed throughout flood period and maximum wind and wave action occurring at time of maximum surcharge.

(4) Tully 1974 criteria. Tully Lake was included in the review of design features of existing dams, and the report completed in January 1974. A summary of the original and 1974 hydrologic design for Tully Lake is presented in table F-9. The maximum surcharge

TABLE F-9

SPILLWAY DESIGN CRITERIA
BIRCH HILL DAM AND TULLY LAKE

Item	Birch Hill Dam		Tully Lake	
	Design Criteria	1974 Criteria	Design Criteria	1974 Criteria
SPILLWAY DESIGN STORM				
Basis of Design	U.S.W.B.	HR No. 33	HR No. 1	HR No. 33
Storm Duration (hrs)	24	24	36	24
Total Volume of Rainfall (in)	22.28	20.3	19.1	20.3
Total Losses (in)	1.2	1.6	1.5	1.6
UNIT HYDROGRAPH				
Unit Rainfall Duration (hrs)	6	3	3	3
Peak Flows (cfs)	2,700	4,850	3,400	1,460(1)
SPILLWAY DESIGN FLOOD				
Peak Inflow to Reservoir (cfs)	59,000	102,000	40,000	36,600
Peak Outflow (cfs)	56,600	93,500	32,700	31,000
Volume of Runoff (acre-feet)	193,000	174,000	41,900	50,000
SPILLWAY DESIGN FLOOD RESERVOIR REGULATION PLAN				
Initial Pool Elevation (ft msl)	852(2)	842(3)	668(2)	658(3)
Outlet Facilities during Flood	Closed	Operable	Closed	Operable
Maximum Surcharge Elev. (ft msl)	859	857.6	678.8	675.7
FREEBOARD CHARACTERISTICS				
Design Wind Velocity (mph)	60		60	
Effective Fetch (miles)	2.25		2.4	
Average Depth (ft)			50	
Wave Runup (ft)	4.5		4.9	
Wind Tide (ft)	0.4		0.2	
Adopted Freeboard (ft)	5.0	5.0	5.2	5.0

(1) For 38 square miles, remaining 12 not considered significant.
(2) Pool initially full to spillway crest elevation.
(3) Pool initially one-half full to spillway crest elevation.

elevation, as computed according to the 1974 criteria, is 3.1 feet lower than that given in the original design criteria and therefore meets all safety requirements for freeboard.

b. Standard project flood. This design flood was not developed for the 1940 Birch Hill Analysis of Design nor for the 1944 Tully Revised Analysis of Design. However, two standard project floods (SPF) were developed as demonstration floods in the watershed. The first measured the effectiveness of the Gardner Local Protection Project, Wrights Reservoir improvements while the second was developed for the Millers River Flood Plain Information Technical Report for Orange and Athol, Massachusetts.

14. FLOOD DAMAGES

a. Flood of September 1938. This record flood caused damages of $7,340,000 in the Millers River basin. The losses were widespread along the entire main stem of the river with industrial losses in Athol, Orange, Irving and Millers Falls and railroad and highway losses accounting for 86 percent of the total. The economy of the basin was paralyzed for months.

b. Recurring losses. Losses at the record flood levels of September 1938 would amount to $19.7 million under 1973 conditions. Operation of Birch Hill Dam and Tully Lake would reduce losses in a recurrence of 1938 floodflows by almost 90 percent. For lesser floods the dams provide a high degree of protection to the communities of Athol, Orange, Irving and Millers Falls.

15. DROUGHTS

a. General. The Millers River watershed lies within the general zone classified as humid, where the average annual precipitation is distributed reasonably well throughout the year. In National Weather Service terminology, a drought is considered to be a period of 14 or more days in which less than 0.1 inch of precipitation falls in a 48-hour period. To the agriculturist, a drought is a lack of soil moisture during the growing season. Hydrologically, a drought is defined as a prolonged period of precipitation deficiency which seriously affects riverflow as well as surface and ground water supplies. Periods of deficient precipitation and runoff have occurred in the watershed.

b. History. The drought history in the watershed extends back more than 100 years. Several periods of below average precipitation

have occurred prior to 1960, although none have caused a serious impact on the water needs of the area due to the sparse population and lack of industry in the region. The most notable of these occurred in 1880 to 1883, 1894, 1930, 1941 and 1949.

c. Drought of 1961-1966. The longest and most severe drought in the history of the Connecticut River basin is the one of 1961-1966. During this period, the cumulative precipitation deficiencies at Winchendon and Turners Falls were 36.1 and 40.9 inches, respectively, which are 86 and 102 percent of the average annual precipitation. The cumulative runoff deficiencies for water years 1961-1966 at Millers River at South Royalston, East Branch Tully River near Athol and Millers River at Erving, were 34.0, 48.2 and 44.3 inches, respectively, which are 153, 224 and 200 percent of the average annual runoff. Rarely is a deficiency of ground water carried over from one growing season to the next in New England, since it is replenished during each spring runoff. However, this condition occurred in the winter of 1964-1965 and resulted in a record low flow runoff at Millers River at South Roylaston, East Branch Tully River near Athol and Millers River at Erving of 7.4, 6.2 and 7.1 inches, respectively, in water year 1965, which are 33, 29 and 32 percent of the average yearly runoff (refer to plate F-28).

CHAPTER IV

COMMUNICATIONS

16. GENERAL

All communications between the project manager and RCC are made via the NED radio network during normal work hours or when NED headquarters are otherwise manned. Whenever the radio network is inoperative, communications are made by telephone. During nonwork hours, reports and regulation instructions are issued by telephone to or from the homes of RCC personnel. In the event of failure of the NED radio network and telephone service, emergency communications will be attempted through the State Police or Civil Defense radio facilities. In addition, radios located in the Automatic Hydrologic Radio Reporting Network facilities in the field are tied directly to the RCC computer room serving as a backup system for normal radio communication.

17. PRECIPITATION REPORTING NETWORK

Reports of precipitation data from the Millers River watershed are used primarily for the purpose of alerting regulation personnel and of providing a basis for appraising the severity of the storm. The collection and reporting of precipitation data from Birch Hill Dam and Tully Lake is the responsibility of the project managers. The managers also receive calls from observers in the watershed.

The Reservoir Control Center periodically reviews network arrangements to insure that an adequate reporting network is maintained. The River Forecast Center in Hartford, Connecticut receives precipitation reports from observers in and near the Millers River watershed, which are made available to RCC upon request. In addition, cooperative reporting procedures from all Corps dams have been established with the River Forecast Center and have been detailed in separate memos to each project manager. Locations of the NED and the National Weather Service precipitation stations are shown on plate F-3.

18. RIVER REPORTING NETWORK

a. General. A network of river stage observation stations, which is part of an overall river reporting system for the Connecticut

River basin has been established. This network assists in the execution of the reservoir regulation plan by permitting personnel in RCC or at the dams to obtain river stages at selected key index stations located either on tributaries or on the Connecticut River.

b. River reporting system. The river reporting system in the Millers River watershed consists principally of the following stations, listed in downstream order: (1) the staff gage at the Main Street bridge at Athol, (2) the staff gage located just upstream of the Main Street bridge in Orange and (3) the USGS recording gage at Erving. The locations of these stations are indicated on plate F-3. These observations are obtained by the project managers. The Montague City and Springfield telemarks on the Connecticut River are also used in the river reporting system. Complete information concerning other key locations along the Connecticut River and its tributaries are obtained from other project managers of flood control projects and the River Forecast Center.

19. AUTOMATIC HYDROLOGIC RADIO REPORTING NETWORK

The effective regulation of flood control projects in New England, consisting of 35 flood control dams and 4 hurricane barriers, requires a reliable and rapid method of collecting and coordinating hydrologic data by the Reservoir Control Center. In January 1970, the installation of an Automatic Hydrologic Radio Reporting Network was completed.

Radio gaging stations have been established at the following locations in the Connecticut River basin:

Passumpsic River at Passumpsic, Vermont
Connecticut River at Wells River, Vermont
White River at West Hartford, Vermont
Connecticut River at White River Junction, Vermont
Connecticut River at North Walpole, New Hampshire

Deerfield River at West Deerfield, Massachusetts
Connecticut River at Montague City, Massachusetts
Conant Brook at Monson, Massachusetts
Chicopee River at Indian Orchard, Massachusetts
Westfield River at Westfield, Massachusetts

Connecticut River at Springfield, Massachusetts
Mad River Lake at Winchester, Connecticut
Farmington River at Collinsville, Connecticut
Farmington River at Rainbow, Connecticut
Connecticut River at Hartford, Connecticut

Details of the computer controlled radio hydrologic reporting network are covered in the "Guidance Memorandum, Reservoir Control Center," dated September 1971 and will also be covered in the "Connecticut River Master Manual of Reservoir Regulation."

20. REPORTS

a. Weekly reports. The project manager makes a routine report by radio (or telephone) to RCC each Friday morning. This report insures continuous contact between the operating personnel and the RCC and also serves as a check on the communications network. The report includes the preceding 24-hour precipitation, current weather conditions, reservoir pool stage, regulation data, river conditions at index stations, and other miscellaneous data. A sample of the completed form is shown on plate F-42.

b. Alerting reports. An alerting report is promptly made and includes pertinent data that is readily available along with a general appraisal of local conditions although data from all the precipitation or flood index stations may not be available. Whenever any of the following conditions occur, the manager will immediately notify RCC:

(1) Precipitation. Occurrence of 1 inch precipitation during any 24-hour period at either Birch Hill Dam or Tully Lake or at any precipitation stations within the watershed or vicinity.

(2) Reservoir stages.

(a) Nonfreezing season. A reservoir stage of 6 feet and rising at Birch Hill Dam or a reservoir stage of 19 feet and rising at Tully Lake.

(b) Freezing season. A reservoir stage of 6 feet and rising at Birch Hill Dam or a reservoir stage of 15 feet and rising at Tully Lake.

(3) River stages. Whenever the Millers River at the Main Street gage in Athol rises to a stage of 0 feet and is rising.

(4) Unusual conditions. Unusual local conditions such as difficulty with the gates, ice jams, excessive debris, bridge failures, etc., will be reported.

c. Supplemental reports. Supplemental radio (or telephone) reports are made to RCC by the manager either following instructions

from RCC or if it appears that flood conditions might develop in the watershed as the result of melting snow, ice jams, dam failures or heavy localized rainfall. The time and frequency of these reports are dependent upon the severity of conditions and specific instructions from RCC. Plate F-43 shows a typical reporting log which indicates the data to be included in reports by the project manager during flood periods. Insofar as practicable, the following information is included in the flood report to RCC.

(1) Precipitation at dam. The total amount of precipitation which has fallen up to the time of reporting and several intermediate amounts with times of observation.

(2) Reservoir stage. The pool stage at time of reporting and several previous readings with corresponding times to determine the rate of rise and define the inflow hydrograph. Accurate readings of stage and time are essential to facilitate computations by RCC (see plates F-44 through F-46, inclusive).

(3) Gate positions. Gate openings and discharges at time of reporting and at beginning of storm. Any gate changes since preceding report should be included with corresponding stage and discharge.

(4) Precipitation reports from observers. Rainfall data received from cooperative observers.

(5) River stages. Millers River stages with times of observations from gages at Athol, Orange and Erving as requested by RCC.

(6) Snow cover. General snow cover which may affect runoff conditions throughout the basin.

(7) Miscellaneous data. Any other information which might be pertinent such as temperature, etc.

d. Special reports. A special report is submitted by the manager to RCC whenever unusual circumstances occur during a flood or as requested by RCC. The report may be written in longhand and should describe the subjects outlined below if appropriate.

(1) Observations at dam. The manager makes general observations of conditions occurring at the outlet works as listed on the following page. The observations are entered in the log book at the dam. If possible, photographs are taken of any unusual conditions, noting the date, time, the reservoir gage heights and position of the gates.

(a) Extent and action of eddies and waves in the vicinity of the conduit intakes and portals.

(b) Extent and action of turbulence or eddies downstream of the spillway and outlet works.

(c) Effect on the flow through the gates due to an accumulation of ice or debris at the intake.

(d) The pool elevation and position of the gates at which vibration may develop.

(e) Any other unusual hydraulic phenomena that may occur.

(2) Observations at downstream control points. During periods of reservoir regulation, particularly while emptying the reservoir, reconnaissance of downstream conditions is made by either or both managers, upon specific authorization of RCC, to obtain further data on the safe channel capacity in any of the downstream damage areas or control points on the Millers or Connecticut Rivers.

e. Snow survey reports. Snow courses have been established at selected locations within the reservoir watershed. Weekly surveys are made by the managers during the winter and early spring to determine the depth of snow and its equivalent water content. Dates for surveys are established each year by RCC so as to correspond with monthly bulletins of the U.S. Geological Survey and supplemental data from power companies. The report will contain the name of the station, the snow depth and water equivalent.

f. Hartford River Forecast Center report. The project manager at Birch Hill Dam or Tully Lake will make a daily telephone call at 0815 hours to the Hartford River Forecast Center for the purpose of transferring hydrologic and climatologic conditions at the reservoirs to the National Weather Service. This data is used to develop a Millers River headwater statement. The statement is transmitted to RCC twice weekly and gives the amount of rainfall in six hours required to produce runoff varying from .25 to 5 inches into our reservoirs. The following parameters will be reported on a 7-day basis:

Dam	Depth of new snow
Date	Total depth of snow
Time of observation	Temperature - maximum preceding 24 hours
Precipitation (24-hour)	Temperature - minimum preceding 24 hours
Form precipitation	Temperature - current
Present weather	

21. SPECIAL ADVISORIES

In accordance with regulations set forth in EM 500-1-1, "Domestic Emergency Operations," and the "Guidance Memorandum, Reservoir Control Center," special advisories from RCC on flood potential and progress of all threatening storms are submitted to the Division Engineer and to the Chiefs of Engineering and Operations Division. Flood reports are also prepared for OCE by the Reservoir Control Center.

22. MAINTENANCE OF LOG

All reports, instructions, records of unusual circumstances at the dam, and information pertinent to regulation of the reservoir are entered in the logs. A log is maintained by both the project manager and Reservoir Control Center.

23. GATE OPERATION RECORD

All gate operations are carefully noted on NED Form 90, a sample of which is shown on plate F-47 and submitted biweekly to RCC. All operations are noted regardless of the duration of the change in gate position. The report includes data and time of day, reservoir stage, outflow, precipitation, gate opening, tailwater reading and remarks column. RCC personnel utilize the Form 90's in the preparation of the monthly charts of reservoir regulation.

CHAPTER V

HYDROLOGIC FORECASTS

24. NATIONAL WEATHER SERVICE

a. Weather forecasts. The National Weather Service in Boston, Massachusetts is responsible for issuing daily weather forecasts for public dissemination through the news media. These reports are received at RCC approximately four times each day on the Weather Service teletype loop.

b. Precipitation forecasts. In addition to the normal weather forecasts, quantitative precipitation forecasts are received daily by RCC. Supplemental weather information and forecasts prior to or during floods are made available upon request.

c. River forecasts. The River Forecast Center at Hartford, Connecticut is responsible for preparing and disseminating flood forecasts for the Connecticut River and some of the principal tributaries. The Center also prepares and transmits biweekly forecasts by teletype to RCC indicating the amount of 6-hour rainfall necessary to produce runoff varying from .25 to 5 inches into our reservoirs and the amount of rainfall required to produce flood conditions on selected tributaries below our projects. Although flood forecasts are not specifically given for the Millers River, they are given for nearby watersheds and are indicative of hydrologic conditions in the area. Flood forecasts are also given for the Connecticut River at the following locations: North Walpole, Montague City, Springfield and Hartford.

25. CORPS OF ENGINEERS

a. Millers River forecasts. During flood periods in the Millers River watershed, the Birch Hill and Tully reservoirs are operated principally to protect the downstream community of Athol. The flat gradient of the Millers River, and the construction of the Mortons Meadow Housing Development in the Athol flood plain in the late 50's has resulted in a limited non-damaging channel capacity of only 3,100 cfs, equivalent to 11 csm. The two reservoirs control 80 percent of the drainage area at Athol, 71 percent at Orange, and 60 percent at the Erving gage. Operating experience for the past 30 years has shown

that the regulation of the reservoirs for Athol results in providing protection to all other downstream locations, where channel capacities are much greater, for example, 6,000 cfs at Erving.

During a flood period the Tully reservoir manager continually monitors river stages at the Main Street gage as directed by RCC (it takes him about 15 minutes to drive to the gage). The high flow travel time from Tully Lake to the Athol gage is 2-3 hours, from Birch Hill Dam, 4-5 hours. Taking into consideration these hydrologic characteristics of the Millers watershed and the fact that RCC continually receives weather forecasts, National Weather Service quantitative precipitation forecasts and flood forecasts, data from the automatic hydrologic radio reporting system and the other 25 manned dams, it has not been considered necessary to develop a specific flood forecasting procedure for the Millers River.

b. Future flood forecasts. The Master Manual for the Connecticut River basin has been initiated and will include procedures for Connecticut River flood forecasting and releasing of stored waters from the entire reservoir system during the recession of the flood.

In December 1971, the Reservoir Control Center requested the Hydrologic Engineering Center to initiate studies to develop a flood forecasting technique for the Merrimack River basin based on "real time" data collected from the Automatic Radio Reporting Network, flood control dams and other sources. Results and findings of this study, scheduled for completion in FY 1976, will be utilized in determining forecast procedures for the Connecticut River basin.

CHAPTER VI

RESERVOIR REGULATION

26. PLAN - GENERAL OBJECTIVES

The general objective of the regulation procedures for the Millers River watershed is to provide a comprehensive tool for guiding those responsible for operating Birch Hill Dam and Tully Lake in accomplishing the missions for which these projects were authorized. This plan will allow for the most efficient protection of immediate downstream communities on the Millers River and communities further downstream on the Connecticut River. This plan will make efficient use of water available on a seasonal basis for recreation at Tully Lake without adversely affecting the flood storing capability of the lake.

27. NONFREEZING SEASON

a. Birch Hill Dam. This project was authorized as a dry bed reservoir. The normal gate opening during the nonfreezing season is 4'-4'-4'-4'.

b. Tully Lake. A seasonal recreation pool will be maintained, following the snowmelt in the spring until mid-September, at about 16 feet (elevation 641 feet msl). One gate will be completely closed and the other throttled, depending on the inflow into the reservoir.

28. FREEZING SEASON

a. Birch Hill Dam. A winter pool will not be maintained. During cold weather the flood control gates will be operated daily to prevent them from freezing. The normal gate setting during the freezing season is 3'-3'-3'-3'.

b. Tully Lake. A winter pool will be maintained at about stage 11 feet (elevation 636 feet msl) to prevent the flood control gates from freezing. One gate will be completely closed and the other opened to maintain a constant pool. The Reservoir Control Center will instruct the project manager when the winter pool is to be established in the fall, and raised in the spring.

29. FLOOD CONTROL

a. Objective. The flood control objectives of both Birch Hill Dam and Tully Lake are directed to provide flood protection to Athol, Orange and other downstream communities on the Millers River and, secondarily, in conjunction with other flood control reservoirs in the Connecticut River basin, to alleviate flooding downstream communities on the main stem of the Connecticut River.

b. Operating constraints.

(1) Minimum releases. A minimum release of about 10 to 20 cfs must be maintained from both projects during periods of regulation in order to sustain downstream fish life.

(2) Flowage easements. The original authorizations for both Birch Hill and Tully allowed for flowage easements only to spillway crest (Birch Hill 852 feet msl = 37 foot stage; Tully 668 feet msl = 43 foot stage). Therefore, during a severe flood the possibility exists of causing damage upstream of Birch Hill at the sewage treatment facility in Winchendon and in the community of Baldwinville on the Otter River. A plan view of the dike system surrounding the sewage treatment facility is shown on plate F-59. The sludge beds begin to be inundated when the Birch Hill pool reaches spillway crest elevation. A decision will have to be made to either utilize surcharge storage or to increase regulated discharges to prevent surcharge storage and possibly result in downstream damage. There are no problem areas immediately above spillway crest at Tully Lake.

(3) Recreation area.

(a) Birch Hill Dam. The Lake Dennison recreation facility is comprised of 82-acre Lake Dennison, 200-acre camping facility, 150 tent or trailer sites and 7 sanitary facilities. If possible, consideration should be given to try and prevent inundation of these facilities. The lake surface elevation is 821 feet msl (6-foot stage), however, damages do not begin until approximately 825 feet msl (10-foot stage) when the pool inundates the lowest lavatory. The project manager should consider notifying the Massachusetts Department of Natural Resources personnel at the camping site at a stage of 10 feet and rising, that the pool is rising and could cause difficulties at the campgrounds.

(b) Tully Lake. There are no structures in the reservoir area that cause operating constraints.

30. FLOOD PERIOD

a. General. Regulation of flows from Birch Hill Dam and Tully Lake are initiated for heavy rainfall occurring over the Millers River watershed and also for specific river stages at key Millers and Connecticut River index stations. Regulation may be considered in three phases during the course of a flood: Phase I, the appraisal of storm and river conditions during the development of the flood leading to the initial regulation; Phase II, regulation of projects while the Millers River and/or Connecticut River floodflows crest and move downstream; Phase III, emptying the reservoir following the downstream recession of the flood. The standard operating procedures (SOP) for regulating the reservoirs are shown on plate F-48.

b. Phase I - Initial regulation of discharge. During this phase it is important to collect rainfall and discharge data in order to appraise the development and magnitude of a flood in the basin. Gate operations at Birch Hill Dam and Tully Lake will be initiated to restrict the reservoir discharge in accordance with the SOP shown on plate F-48. The portion of the total to be released from each reservoir will be as directed by the RCC.

Consideration will be given to partial closure of the gates at both projects (Birch Hill 1'-1'-1'-1'; Tully 0'-1') for any of the following conditions:

(1) Whenever a rainfall of two inches on snow-covered, wet or frozen ground, or three inches on dry ground occurs within a 24-hour period at either dam or at any station within the Millers River watershed or vicinity.

(2) Whenever the stage at the Main Street bridge staff gage at Athol reaches 1.5 feet during the growing season or 2.0 feet during the non-growing season and is rising. A stage-discharge curve is shown on plate F-49.

(3) To restrict the contribution from the reservoirs when the Connecticut River at Montague City approaches a stage of 25 feet during the growing season and 28 feet during the non-growing season.

c. Phase II - Continuation of regulation. An important regulation activity during this period is the collection of hydrologic data such as (1) precipitation amounts throughout the entire watershed as well as surrounding areas; (2) snow cover and water content in case of spring floods; (3) stage and discharge values at downstream control

regions have been properly analyzed.

points; (4) other pertinent data which would assist in the regulation. During this phase, the reservoir discharge is regulated to reduce downstream flooding on the Millers and Connecticut Rivers.

As a flood develops, considerable judgment and experience are necessary to vary the regulation in accordance with the amount of residual reservoir storages at Birch Hill and Tully, river stages at Athol and Orange, water content of the snow remaining in the watershed, if any, and weather forecasts. In general, the continuation of regulation will be governed principally by the reservoir pool stages and the stage at the Main Street bridge at Athol.

Secondary river rises from additional rainfall or snowmelt will be considered applicable to Phase II. With rising stages at the Main Street bridge in Athol, consideration will be given to the travel times from the dams to Athol in order to anticipate river stages. Approximate peak travel times to Athol from Birch Hill Dam and from Tully Lake are about 5 and 3 hours, respectively.

The preceding conditions will usually govern the continuation of regulation in Phase II, but in some cases flood conditions on the Connecticut River will be the controlling factor. Regulation in Phase II will continue until the RCC has determined that the flood peak has passed Montague City and no longer poses any danger to the immediate areas on the Millers and Connecticut Rivers. Approximate travel times for the watershed are given on page i and on the Standard Operating Procedures (SOP), plate F-48.

Consideration will be given to complete closure of the gates at both projects (Birch Hill 0'-0'-0'-0.1'; Tully 0'-0.1') for any of the following conditions:

(1) Whenever a rainfall of three inches on snow-covered, wet or frozen ground, or four inches on dry ground occurs within a 24-hour period at any station within the watershed.

(2) Whenever the stage at the Main Street bridge staff gage at Athol reaches 3.0 feet.

(3) Whenever the Connecticut River at Montague City approaches a stage of 26 feet during the growing season and 30 feet during the non-growing season.

Three New England Power Company hydroelectric plants (Wilder, Bellows Falls and Vernon) on the main stem of the Connecticut River

are affected by controlled releases from flood control reservoirs operated by the Corps. Only Wilder can release large amounts from storage that could significantly affect Corps operations. Releases by the Corps and the New England Power Company will be coordinated during flood periods.

d. Phase III - Emptying the reservoirs. Following the recession of the flood peaks at downstream index stations of the Millers River, the reservoirs will be emptied as rapidly as possible. The contribution of each reservoir to this total will be as directed by RCC. The following river stages will also govern the release rates from both reservoirs.

(1) Athol gage. This staff gage is located on the downstream side of the Main Street bridge, Millers River in Athol. The Morton Meadows Housing Development for the Elderly, located about 1,500 feet downstream from the bridge, consists of 5 units of 6 apartments each and is an operating constraint. A photograph of the housing development is shown on plate F-50.

Stage in Feet	
1.5	Beginning of damage to crops in growing season.
3.0	Highest stage for normal conditions. Attain this stage at least once each year if runoff conditions are favorable. Notify Morton Meadows Housing Development to reassure citizens that the Corps realizes high flows exist.
3.3	Should not be exceeded except for unusual event. Access roads are just inundated. Have project managers maintain communications with elderly residents.
3.8	Only for a critical flood situation.
4.0	About one foot below floor of lowest unit of Morton Meadows Housing Development. Utility crawl space under building flooded.

(2) Orange gage. This staff gage is located on the upstream side of the Main Street bridge, Millers River, Orange, Massachusetts.

Stage = 3.5 feet Normal maximum stage.

(3) Erving gage. This USGS recording gage is located on the right bank of the Millers River 75 feet downstream from the bridge at Farley, Massachusetts and 2.4 miles downstream from Erving, Massachusetts.

Stage = 6.5 feet — Normal maximum stage representing a flow of 4,600 cfs - 12 csm.

(4) Montague City gage. This gage is located on the left bank of the Connecticut River 75 feet downstream from the Penn. Central Railroad bridge at Montague City, Massachusetts and 7.2 miles downstream from the confluence of the Millers and Connecticut Rivers.

Stage = 26 feet beginning of flood damage during summer growing season.

30 feet beginning of flood damage during non-growing season.

The rate of increase in reservoir discharge from Birch Hill Dam shall not exceed 500 cfs per hour up to 2,000 cfs and 200 cfs per hour over 2,000 cfs. The maximum rate of reservoir drawdown should not exceed 5 feet per 24 hours. The rate of increase in reservoir discharge from Tully Lake shall not exceed 200 cfs per hour up to 600 cfs and 50 cfs per hour over 600 cfs, with the maximum rate of drawdown not to exceed 5 feet per 24 hours. Outlet rating curves for Birch Hill Dam and Tully Lake are shown on plates F-51 through F-54. Following the emptying of the reservoirs, the gates will be set at their normal openings.

Discharge of the water stored at Birch Hill Dam and Tully Lake will be coordinated with releases from other projects in the system in a manner that will allow the Connecticut River flood crests to continue receding. This subject will be described in detail in the "Master Regulation Manual for the Connecticut River Basin."

With the Birch Hill reservoir pool at spillway crest, an inflow of 3 csm (525 cfs) and an outflow of 2,800 cfs, it would require about 10 days to empty the reservoir. With the Tully reservoir pool at spillway crest elevation, an inflow of 3 csm (150 cfs) and an outflow of 800 cfs, it would take about 15 days to empty the flood control pool.

Secondary river rises during Phase III, due to either additional rainfall or snowmelt, may result in the regulation procedures reverting to Phase II.

(5) Safe downstream channel capacities. The maximum safe channel capacity immediately downstream of Birch Hill Dam is 2,800 cfs during the non-growing season and about 2,000 cfs during the growing season. The safe capacity downstream of Tully Lake is about 800 cfs and 650 cfs, respectively. If possible, from a hydrologic viewpoint, releases from each project should reach these maximum figures annually at each project. In order to accomplish this, flows at one project will have to be reduced permitting the other to reach its safe maximum capacity. Care should be taken at all times not to cause damaging flows in Athol.

e. Regulation for snowmelt. Moderately high springtime discharges can occur as a result of melting snow, but runoff from this source alone has not caused major flooding. The snow cover in the lower elevations of Massachusetts and Connecticut usually diminishes before melting takes place in the northern areas of Vermont and New Hampshire. However, the potential snowmelt flood threat period on the Connecticut River and its tributaries is prolonged and generally occurs in March and April because of high riverflows and saturated ground conditions.

Active snowmelt begins when the density of the snowpack rises above 30 percent, i.e., a 10-inch depth of snow having 3 inches of water equivalent. RCC has not developed precise correlations regarding high temperatures-snow density-peak runoff relationships for each tributary. However, operating experience has indicated that after the snowpack becomes "ripe," several days of maximum temperatures in the 50's and 60's would result in flows of up to 8 to 10 csm in the main stem of the Millers River, and discharges up to 20 csm from the smaller, steeper tributaries in the watershed. The runoff from snowmelt alone is diurnal, orderly and gradual, and regulation by RCC personnel will not necessarily follow the release guides established for runoff associated with rainfall. Regulation during periods of snowmelt alone generally will be based on maintaining releases consistent with full downstream channel capacities.

f. Spillway discharge. Ordinarily, during a major flood, the gates will not be opened to avoid spillway discharge. Surcharge storage above the spillway crest will be utilized if the downstream channel capacity continues to be exceeded by the runoff from uncontrolled areas. However, due to the lack of flowage easements above spillway crest at both projects, surcharge storage will be utilized only under severe downstream flooding conditions. It will be necessary to determine which method of operation during a particular flood event will

afford protection for the largest number of people and their property, that is either utilizing surcharge storage or increasing release rates. If the stage in either reservoir continues to rise above the crest with the possibility of the pool rising to the maximum design surcharge, the following schedule will be used as a guide for gate releases during spillway discharges.

Birch Hill Dam		Tully Lake	
Pool Stage	Gate Openings	Pool Stage	Gate Openings
37	0'-0'-0'-0.1'	43	0'-0.1'
40	2'-2'-2'-2'	48	2'-2'
41	4'-4'-4'-4'	49	3'-3'
42	6'-6'-6'-6'	50	4'-4'
43	12'-12'-12'-12' (Fully Open)	51	6'-6' (Fully Open)

The spillway rating curves are shown on plates F-55 and F-56.

g. Alerting of flood affected populace. Whenever it is anticipated that either reservoir will rise above spillway crest elevation during an extreme flood, the project manager will notify the Massachusetts State Police at the Holden Barracks, and the Chiefs of Police at Athol and Orange of the expected uncontrolled spillway discharge conditions. The project manager at Birch Hill Dam will also notify the Chiefs of Police at Winchendon and Baldwinville that portions of their communities might be inundated from water backing up from the dam.

h. Effect of regulation on roads within the reservoirs. There are several roads that pass into or through the reservoir areas that are subject to inundation during the storage of floodwaters. Inasmuch as public safety is involved in the use of these roads, the project managers of these reservoirs are responsible for seeing that these roads are barricaded whenever necessary.

(1) Birch Hill Dam. The project manager should consider barricading roads into the reservoir area at stages of 11, 24 and 37 feet. During the winter months the 11-foot barricades should be

closed at a stage of 9.5 feet. The locations of these barricades are indicated on plate F-4.

(2) Tully Lake. When a rising pool approaches a stage of 22 feet, the manager will barricade the top and bottom of Doane Hill. The manager will keep the barricades at both entrances to old Davis Hill Road, which has a bridge out, permanently closed. Barrier locations are shown on plate F-5.

31. EXTRAORDINARY FLOOD CONDITIONS

It is conceivable that extraordinary circumstances or unpredictable flood conditions may arise such as a possibility of drowning, dam or bridge failures, highway or railroad washouts, ice jams or debris deposits. Since the purpose of the reservoirs is to help save lives and prevent or reduce damage, regulation during such unusual conditions may not follow previously described rules but will be governed by the urgency of the circumstances. During such conditions the project manager has full authority to act immediately in the public interest. RCC will be notified as soon as possible of any unusual incident so that additional action may be taken to provide maximum protection.

32. REGULATION WITH FAILURE OF COMMUNICATION

Should both the Birch Hill and Tully project managers be unable to contact RCC when a flood is developing, the Birch Hill project manager has full authority to act promptly in accordance with the instructions contained in the SOP and will direct the regulation of both reservoirs until communications can be established. Should the project manager at Birch Hill be unavailable for duty, the Tully project manager will direct the regulation of both projects according to the SOP. Refer to plate F-48 and paragraph 30. It should be emphasized that whenever communications fail, or due to lack of adequate reports, and it is impossible to fully appraise the runoff from an intense storm; then it is preferable for either manager to immediately restrict or completely stop the reservoir discharge than to delay regulation and actually contribute to downstream flood conditions.

In cases of extreme emergency, the manager shall attempt to communicate with RCC through the Massachusetts State Police and the office of Civil Defense Mobilization radio networks. In addition, all hydrologic radio reporting stations have radios that transmit directly to RCC. Paragraph 19 gives the location of these stations.

The Birch Hill project manager will regulate the discharges from both reservoirs during Phase I. In case of doubt as to whether a partial or complete gate closure should be made, the gates will be closed completely whenever the severity of the storm and/or lack of information concerning downstream conditions warrant such action.

In the event that the Tully project manager is unable to contact either RCC or the Birch Hill project manager by phone, he or his assistant will drive to Birch Hill Dam to report on flood conditions. Should conditions be such that immediate reduction of the Tully Lake outflow is essential, the Tully project manager has full authority to make the necessary gate adjustments prior to reporting to Birch Hill. Releases for emptying the reservoirs will not be made until contact has been established with RCC. Possession of the instructions contained in this manual does not relieve the project manager of his responsibility for continued efforts to communicate with RCC.

33. EMERGENCY OPERATING PROCEDURES (EOP)

When unable to contact RCC and flood conditions develop, the flood control dam operators have full authority to regulate the gate openings in accordance with instructions as follows:

EMERGENCY OPERATING PROCEDURES

a. Partial gate closure for any of the following conditions:

	Birch Hill		Tully	
	Non-growing Season	Growing Season	Non-growing Season	Growing Season
Gate Settings	1'-1'-1'-1'	1'-1'-1'-1'	0'-1'	0'-1'
(1) Rainfall during a 24-hour period.				
snow-covered, wet or frozen ground	1.5"	1.5"	1.5"	1.5"
dry ground	2.0"	2.0"	2.0"	2.0"
(2) Stage, Millers R. at Main St. Bridge, Athol	2.0'	1.5'	2.0'	1.5'
(3) Stage, Conn. R. at Montague City	26'	25'	26'	25'

b. Complete gate closure for any of the following conditions:

	Birch Hill		Tully	
	Non-growing Season	Growing Season	Non-growing Season	Growing Season
Gate Settings	0'-0'-0'-0.1'	0'-0'-0'-0.1'	0'-0.1'	0'-0.1'
(1) Rainfall during any 24-hour period.				
snow-covered, wet or frozen ground	2"	2"	2"	2"
dry ground	3"	3"	3"	3"
(2) Stage, Millers R. at Main St. Bridge, Athol	3.0'	2.0'	3.0'	2.0'
(3) Stage, Conn. R. at Montague City	28'	28'	28'	28'

c. Emptying the reservoir. Emptying the reservoir shall not be initiated until contact has been established with RCC.

34. COOPERATION WITH DOWNSTREAM WATER USERS

It is the policy of the Corps of Engineers to cooperate with downstream water users and other interested parties or agencies. Photographs of dams at Chase Machine Company and Lake Rohunta are shown on plates F-60 and F-50, respectively. The locations of these dams are shown on watershed map (plate F-3) and watershed profiles (plate F-24). The manager may be requested by downstream users to deviate from normal regulation for short periods of time. Whenever a request for such modification is received, the manager shall ascertain the validity of the request and obtain assurance from other downstream water users that they are agreeable to the proposed operation. The operator will then relay the information to RCC and request instructions. A minimum release from both projects for downstream fish life shall always be maintained during periods of regulation.

35. ABSENCE FROM DAM

RCC and the basin manager are notified whenever the project manager expects to be away from the dam either overnight or for an extended period.

36. SEDIMENTATION

Sedimentation ranges and monuments have not been installed in the reservoir areas. Experience from other reservoir projects in New England has shown that only minimal amounts of sedimentation can be expected to take place.

37. FUTURE STUDIES

Post flood studies will be made of each reservoir regulation period to determine efficiency of communications and reporting networks, the applicability of regulation guides, including stage-discharge relationships, discharge correlations and flood reductions, at damage centers.

CHAPTER VII

HYDROLOGIC EQUIPMENT

38. PRECIPITATION GAGE

A standard weighing and recording NWS precipitation gage has been installed at Birch Hill Dam. The Tully Lake project manager has a non-recording precipitation gage at his dwelling. These gages serve as a supplement to other NWS rainfall stations within or in the vicinity of the Millers River watershed.

39. RESERVOIR STAGE RECORDER

The automatic float-operated water level recorders at Birch Hill and Tully trace the water level in the reservoirs at all times. The recording instruments should be checked each morning to assure that the clock is keeping correct time and the pen is tracing properly. Any discrepancies in the record as evidenced by the pen time or gage height should be noted on the chart, and the instrument should be reset. During periods of reservoir storage, the outside tile or staff gage should be read to check tape readings and chart records. Should the recorder become inoperable, RCC should be notified and arrangements will be made to repair the instrument.

The chart record should be changed the first working day of each week (Monday morning) at both Birch Hill and Tully, and the following information should be noted in ink at the beginning and end of each chart:

Outside (tile) gage reading
Pen gage height reading
Watch time
Pen time
Date and name of dam

New charts for weekly recorders should be obtained from the NED warehouse.

40. TAILWATER GAGING STATIONS

USGS gaging stations are located about 1.5 miles downstream of Birch Hill and just downstream of Tully. These stations provide a

continuous official record of releases from the dams. They are equipped with digital-type water stage recorders and are operated and maintained under a cooperative stream gaging program. In addition to the gage at Tully, a remote transmitter is located at the gage and remote receiver recorder in the gatehouse. It is essential that the gages be checked frequently to assure proper operation. If inspection indicates a need for repair, RCC should be notified immediately and arrangements will be made with the USGS to have the equipment repaired.

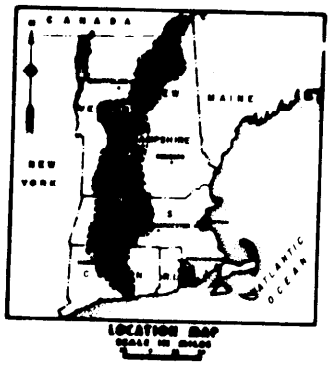
41. TELEPHONE TRANSMITTER (TELEMARK)

The telephone transmitter on the Connecticut River at Montague City is used for regulation in the Millers River watershed. The project managers of Birch Hill and Tully should call the Montague City gage at least once each month to familiarize themselves with its code. During failure of communications, the Millers River projects must regulate for Montague City stages. Should the telemark at Montague City become inoperable during the monthly check, the Birch Hill project manager should notify RCC. If the trouble cannot be determined at the gage, the telephone company should be requested to check out their circuits in the presence of the project manager. If the telemark still is not functioning by this time, RCC should be notified and NED or USGS personnel will inspect the gaging station.

Batteries for the ADR-BDT equipment at the Montague City gage will be furnished and installed by the USGS.

42. SNOW SAMPLING SET

A snow sampling set has been assigned to the project manager at Birch Hill. Snow surveys will be carried out by the project managers and their assistants from both Birch Hill and Tully. Procedures for obtaining snow survey data should follow instructions set forth in "Snow Sampling Guide, Department of Agriculture, Handbook 1960." If given proper care, the only maintenance required would be occasional replacement of wornout cutterheads.



CONNECTICUT RIVER BASIN

SHEET 1 OF 2

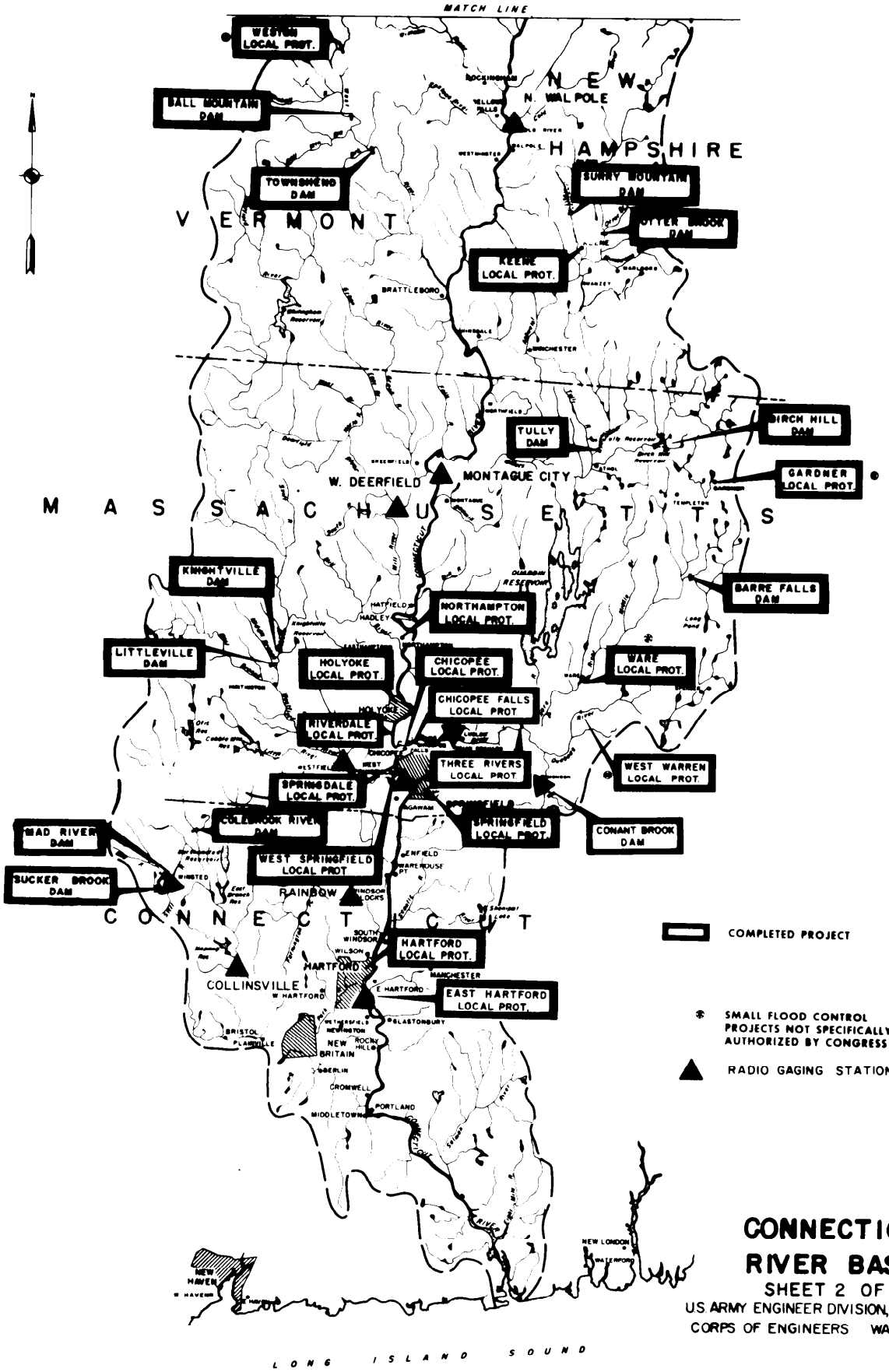
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS WALTHAM, MASS.

SCALE IN MILES

4 0 4 8

DECEMBER 1971

PLATE F-1



CONNECTICUT RIVER BASIN

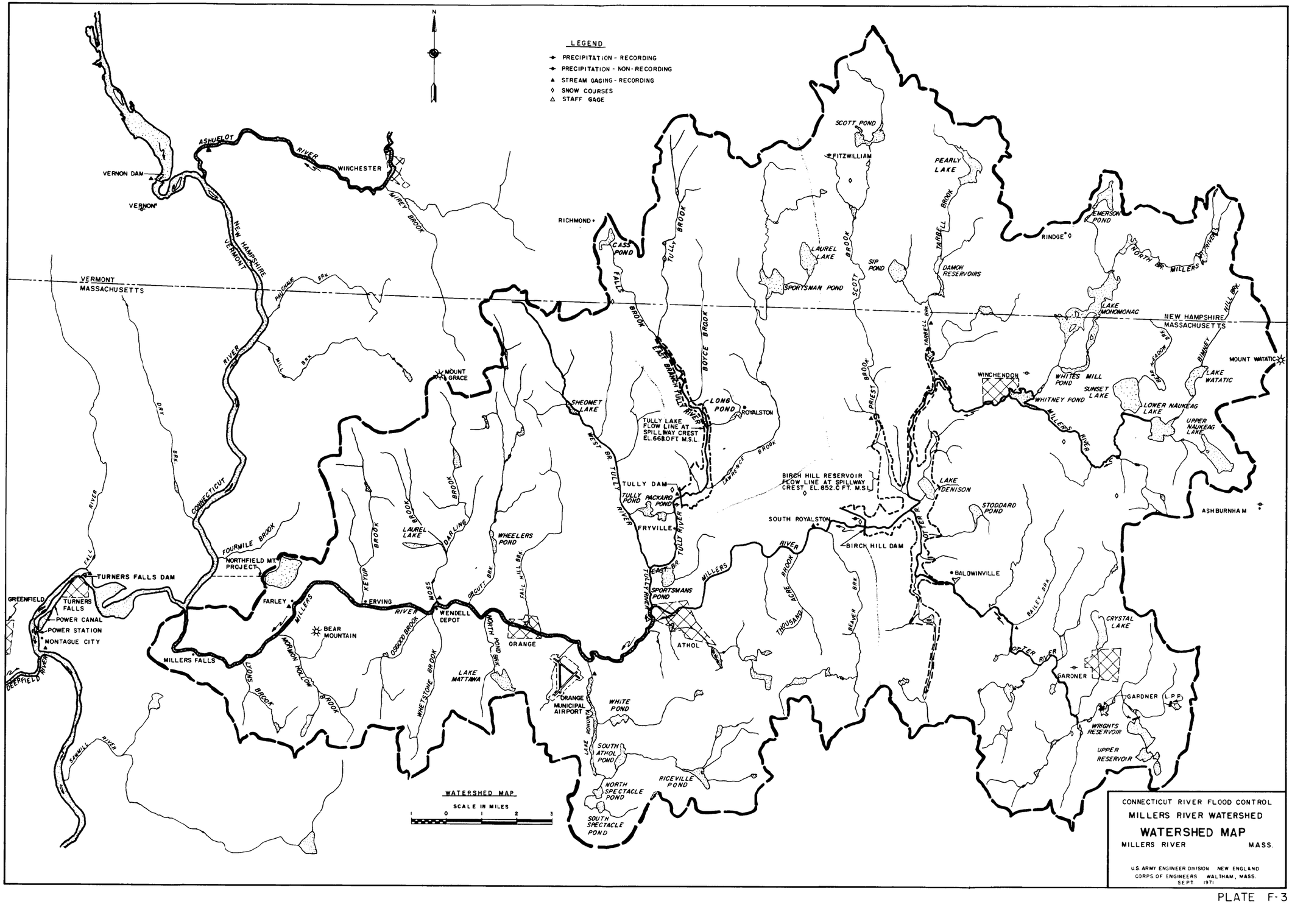
SHEET 2 OF 2

US ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS WALTHAM, MASS.

SCALE IN MILES
0 4 8

DECEMBER 1971

PLATE F-2

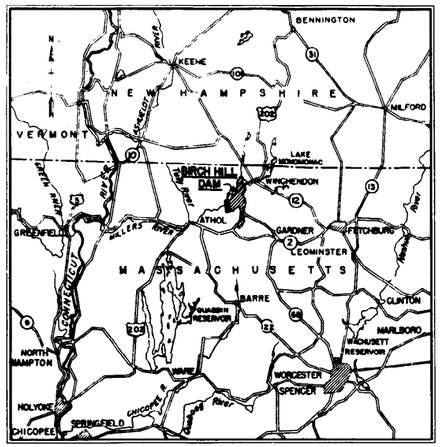


CONNECTICUT RIVER FLOOD CONTROL
MILLERS RIVER WATERSHED
WATERSHED MAP
MILLERS RIVER MASS.

U.S. ARMY ENGINEER DIVISION NEW ENGLAND
CORPS OF ENGINEERS WALTHAM, MASS.
SEPT 1971

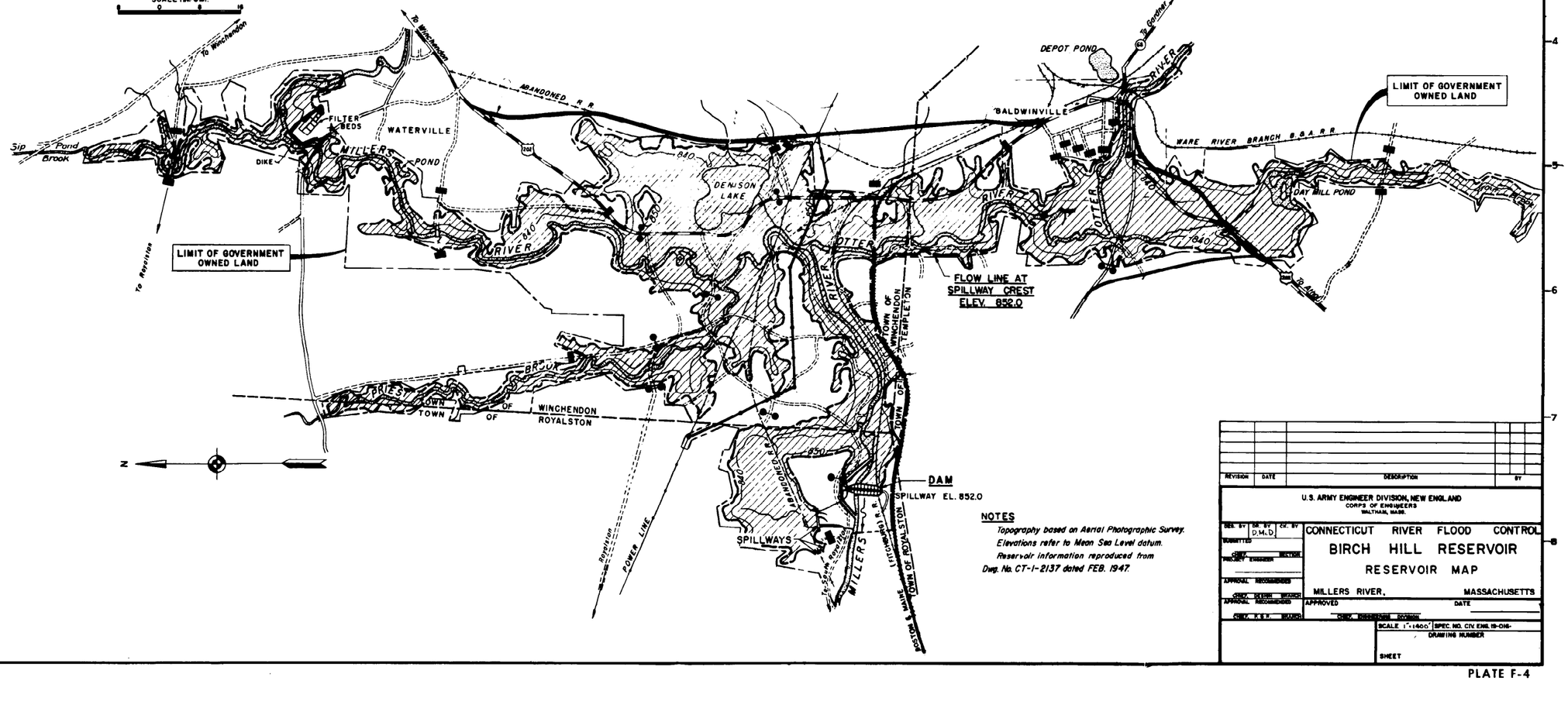
PLATE F-3

CORPS OF ENGINEERS — U. S. ARMY



VICINITY MAP

SCALE 1in = 8 MI.



LEGEND

- ■ — Roads to be barricaded when pool approaches Spillway Crest, Stage-37'
- x—x — Roads to be barricaded when pool approaches Stage-24'
- ●—● — Roads to be barricaded when pool approaches Stage-11'(9.5' when ground is snow covered.)

See paragraph 30h. for further instructions.

NOTES

Topography based on Aerial Photographic Survey.
Elevations refer to Mean Sea Level datum.
Reservoir information reproduced from Dwg. No. CT-1-2137 dated FEB. 1947.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY D.M.D. | CH. BY

SUBMITTED — CHIEF, PROJECT ENGINEERING SECTION

APPROVAL RECOMMENDED — CHIEF, DESIGN BRANCH

APPROVAL RECOMMENDED — CHIEF, R.E.D. BRANCH

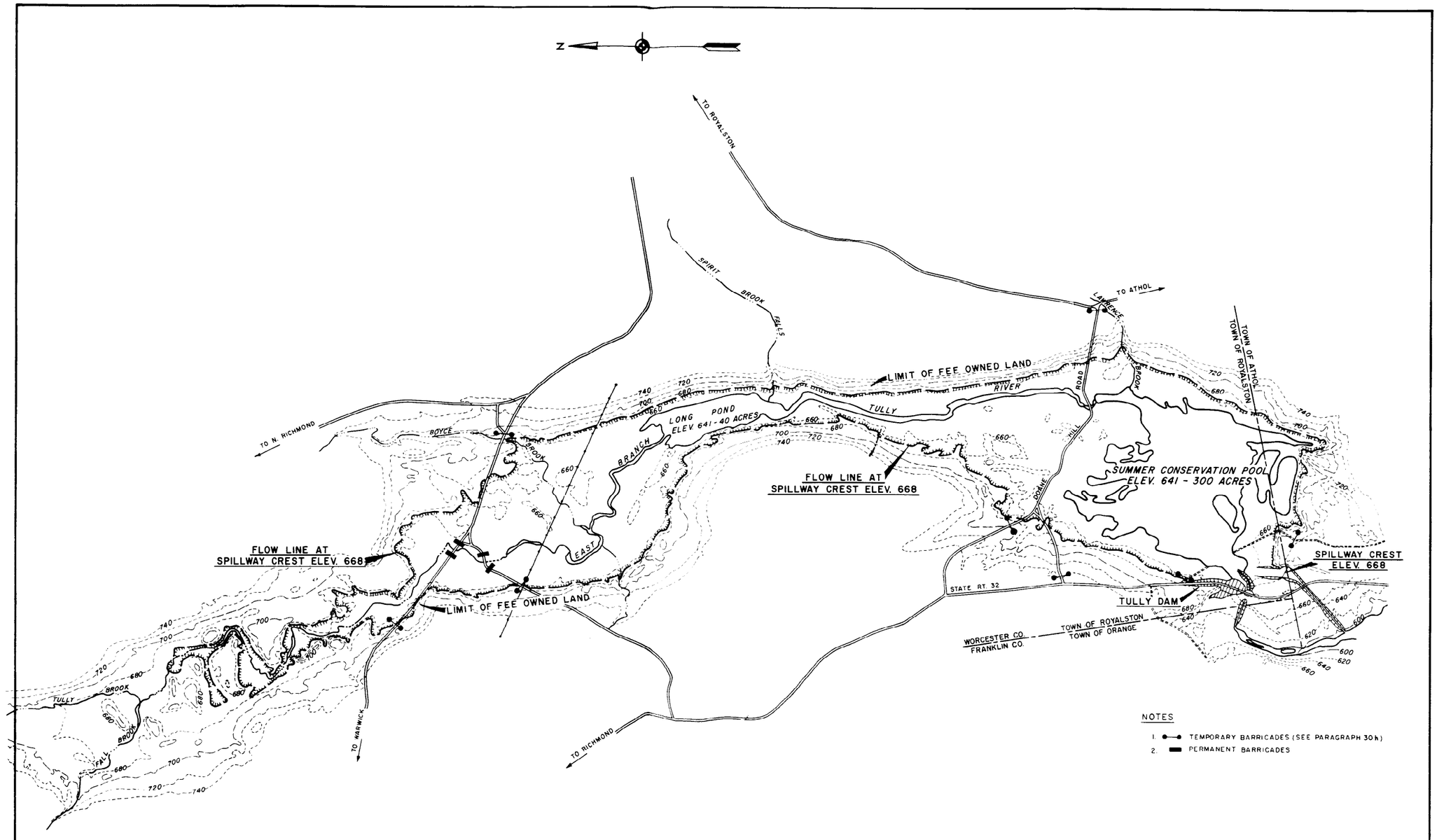
CONNECTICUT RIVER FLOOD CONTROL
BIRCH HILL RESERVOIR
RESERVOIR MAP
MILLERS RIVER, MASSACHUSETTS

APPROVED — CHIEF, ENGINEERING DIVISION — DATE

SCALE 1"=1600' | SPEC. NO. CIV ENG 19-016-
DRAWING NUMBER

SHEET

PLATE F-4



NOTES

1. TEMPORARY BARRICADES (SEE PARAGRAPH 30h)
2. PERMANENT BARRICADES

SCALE IN FEET
800' 0 800' 1600'

CONNECTICUT RIVER FLOOD CONTROL

TULLY RESERVOIR

MASTER PLAN

GENERAL DEVELOPMENT PLAN

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS JUNE 1965
SCALE AS SHOWN

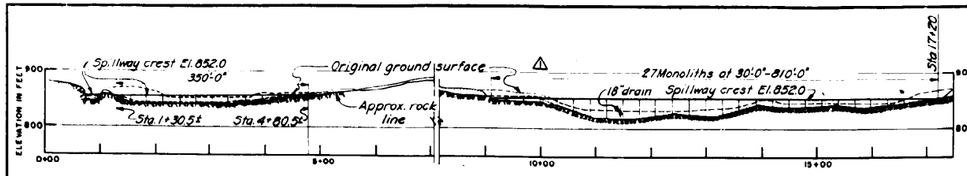
PLATE F-5

WAR DEPARTMENT

CORPS OF ENGINEERS

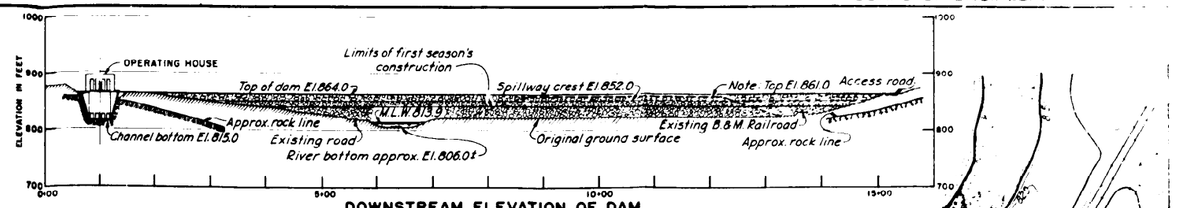
DOWNSTREAM ELEVATION OF SPILLWAY

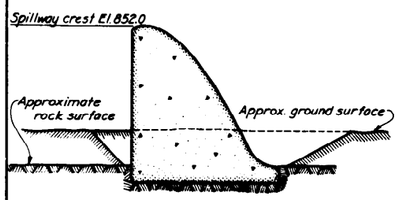
SCALE 1" = 100'



DOWNSTREAM ELEVATION OF DAM

SCALE 1" = 100'



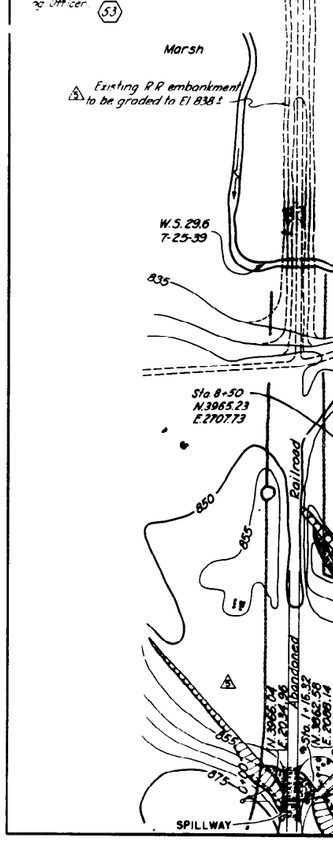


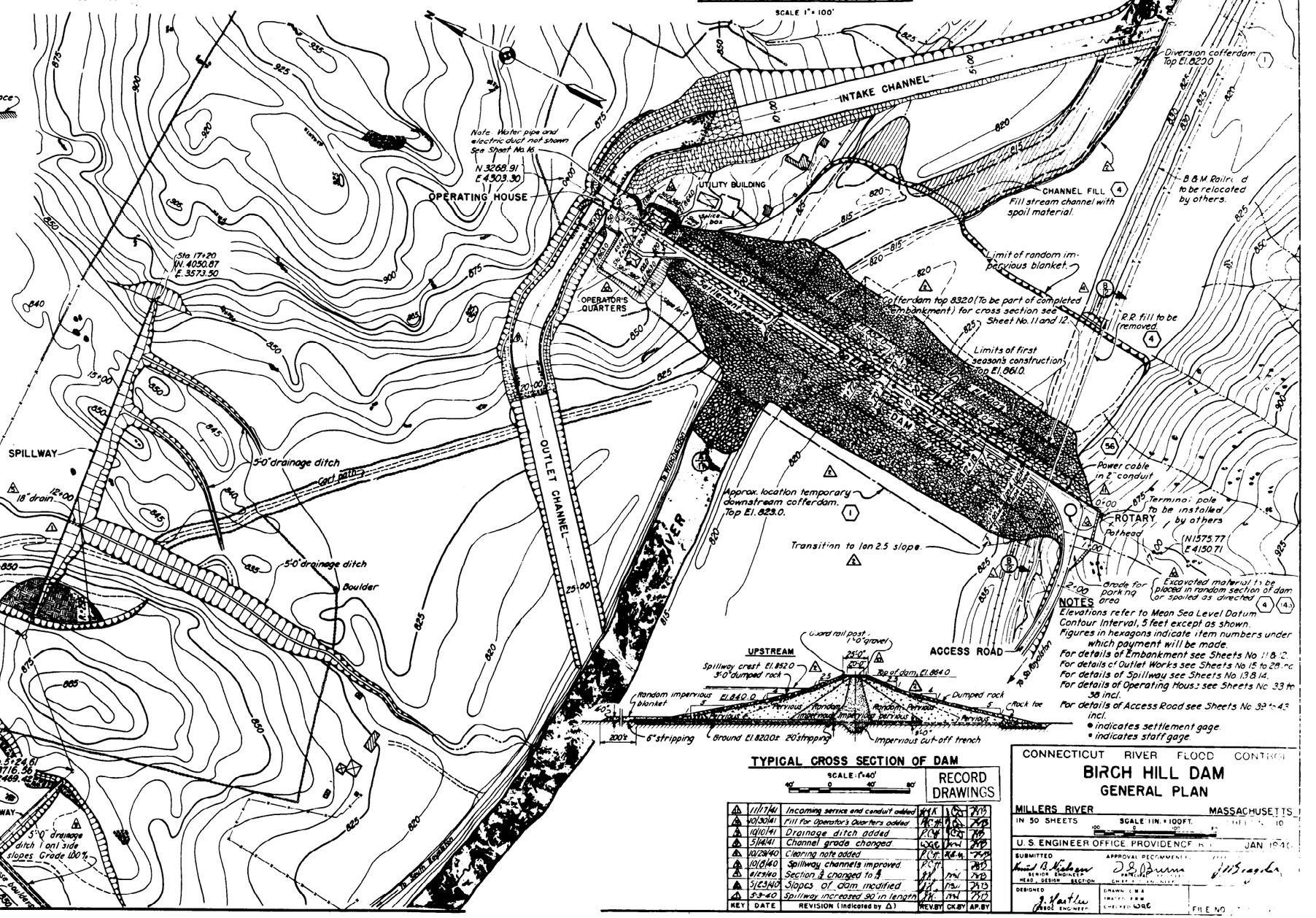
TYPICAL SECTION OF MAIN SPILLWAY

SCALE 1" = 10'

NOTE △5 Existing R.R. embankment to be graded to El. 833± where it crosses spillway approach channel. This work is to be done for a distance of approximately 1000 feet, beginning at a point 3,300± feet northeast of the proposed 30 foot spillway weir in existing railroad cut. Cross section similar to Section H/13 (4)

△6 Clear as directed by the Contracting Officer (53)





TYPICAL CROSS SECTION OF DAM

SCALE: 1"=40'

NOTES

Elevations refer to Mean Sea Level Datum.
Contour interval, 5 feet except as shown.
Figures in hexagons indicate item numbers under which payment will be made.
For details of Embankment see Sheets No. 11 & 12.
For details of Outlet Works see Sheets No. 15 to 28 incl.
For details of Spillway see Sheets No. 13 & 14.
For details of Operating House see Sheets No. 33 to 38 incl.
For details of Access Road see Sheets No. 39 to 43 incl.
• indicates settlement gage.
• indicates staff gage.

RECORD DRAWINGS

KEY	DATE	REVISION (Indicated by △)	REV. BY	CK. BY	AP. BY
△	11/17/41	Incoming service and conduit added	[illegible]	[illegible]	[illegible]
△	10/30/41	Fill for Operator's Quarters added	[illegible]	[illegible]	[illegible]
△	10/10/41	Drainage ditch added	[illegible]	[illegible]	[illegible]
△	5/14/41	Channel grade changed	[illegible]	[illegible]	[illegible]
△	10/28/40	Clearing note added	[illegible]	[illegible]	[illegible]
△	10/8/40	Spillway channels improved	[illegible]	[illegible]	[illegible]
△	8/23/40	Section 3 changed to 4	[illegible]	[illegible]	[illegible]
△	5/23/40	Slopes of dam modified	[illegible]	[illegible]	[illegible]
△	5-3-40	Spillway increased 90' in length	[illegible]	[illegible]	[illegible]

CONNECTICUT RIVER FLOOD CONTROL

BIRCH HILL DAM

GENERAL PLAN

MILLERS RIVER MASSACHUSETTS

IN 50 SHEETS SCALE: 1 IN. = 100 FT.

U.S. ENGINEER OFFICE PROVIDENCE, R.I. JAN. 1940

SUBMITTED: Neal A. Nickerson, SENIOR ENGINEER, HEAD, DESIGN SECTION

APPROVAL RECOMMENDED: D. D. Burns, PRINCIPAL ENGINEER, CHIEF, ENGINEERING DIVISION

DESIGNED: J. Martin, PROJECT ENGINEER

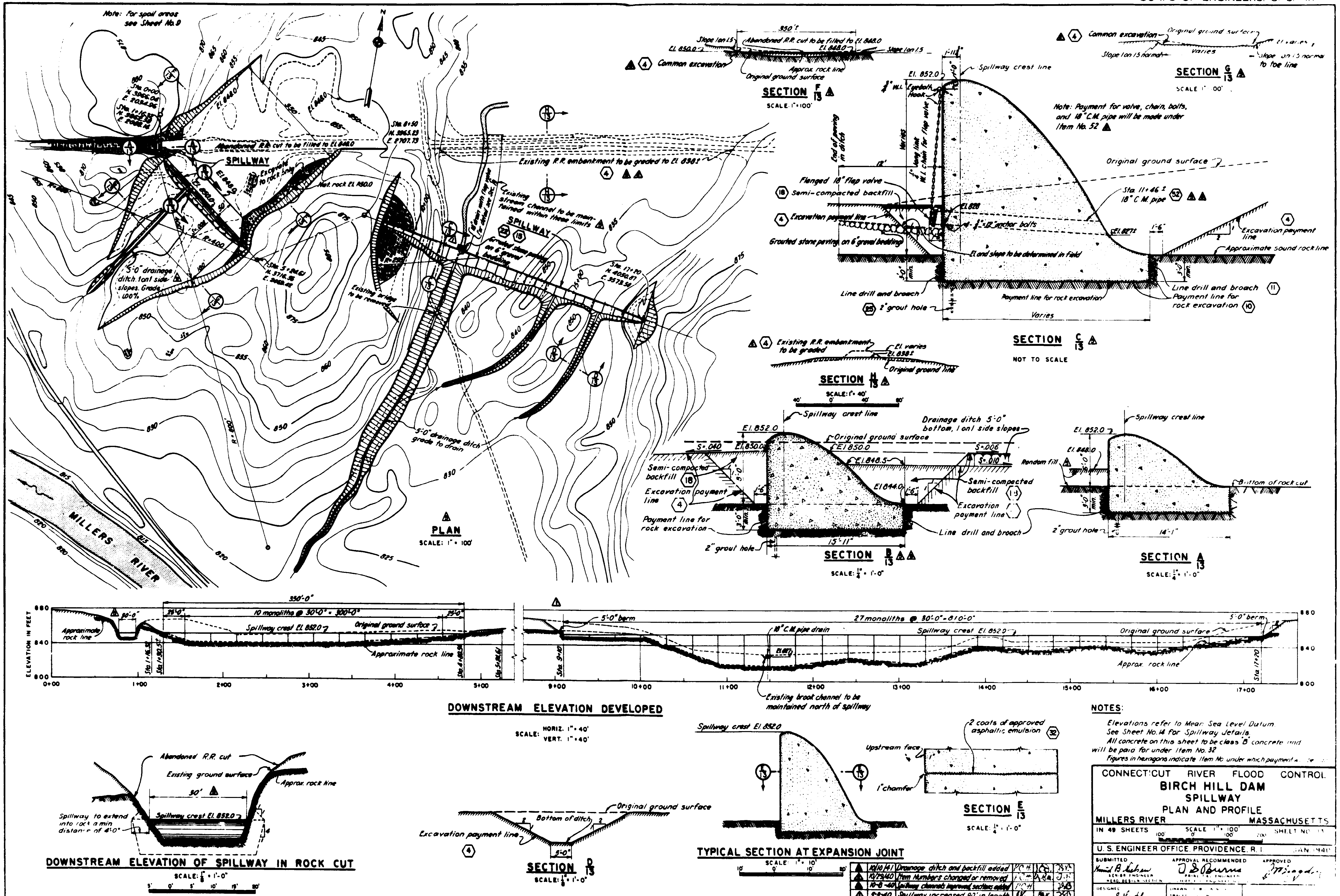
DRAWN: C.M.S.

TRACED: F.G.M.

CHECKED: D.D.C.

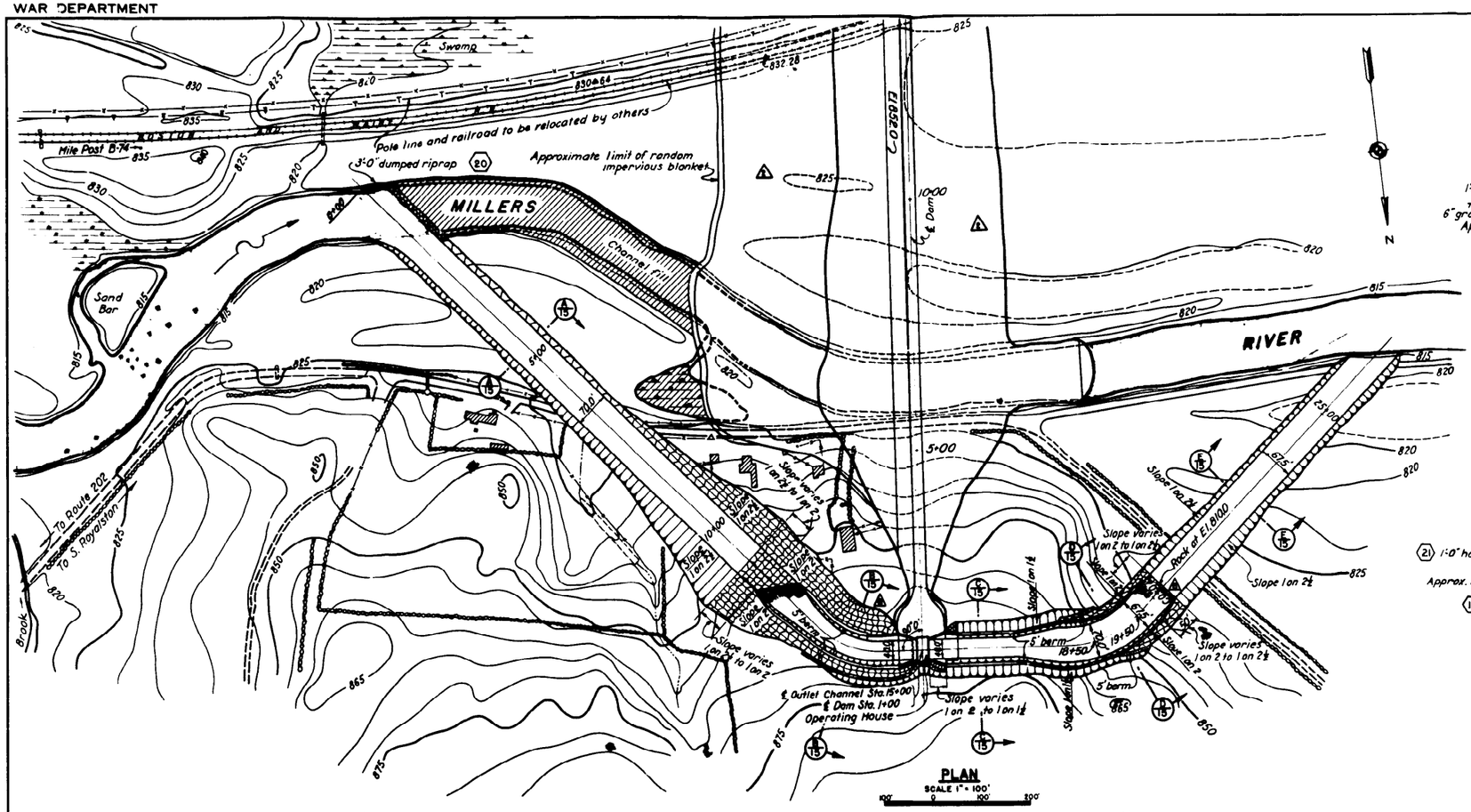
FILE NO. [illegible]

PLATE F-6


Note: For spoil areas see Sheet No. 9
SPILLWAY
Abandoned R.R. cut to be filled to El. 848.0
Existing R.R. embankment to be graded to El. 858±
Existing stream channel to be maintained within these limits
5'-0" drainage ditch 1 on 1 side slopes. Grade 1.00%
5'-0" drainage ditch grade to drain
Existing bridge to be removed
MILLERS RIVER
PLAN
SCALE: 1" = 100'
SECTION F/13
SCALE: 1" = 100'
Common excavation
Original ground surface
Approx. rock line
SECTION G/13
SECTION H/13
SCALE: 1" = 40'
Existing R.R. embankment to be graded
Note: Payment for valve, chain, bolts, and 18" C.M. pipe will be made under Item No. 52
Spillway crest line
Flanged 18" flap valve
Semi-compacted backfill
Excavation payment line
Grouted stone paving on 6" gravel bedding
El. and slope to be determined in field
Line drill and broach
Payment line for rock excavation
2" grout hole
Approximate sound rock line
SECTION C/13
NOT TO SCALE
SECTION B/13
SCALE: 1/4" = 1'-0"
Drainage ditch 5'-0" bottom, 1 on 1 side slopes
Random fill
Bottom of rock cut
SECTION A/13
SCALE: 1/4" = 1'-0"
DOWNSTREAM ELEVATION DEVELOPED
SCALE: HORIZ. 1" = 40' VERT. 1" = 40'
10 monoliths @ 30'-0" = 300'-0"
27 monoliths @ 30'-0" = 810'-0"
Spillway crest El. 852.0
Approximate rock line
18" C.M. pipe drain
Existing brook channel to be maintained north of spillway
DOWNSTREAM ELEVATION OF SPILLWAY IN ROCK CUT
Abandoned R.R. cut
Existing ground surface
Approx. rock line
Spillway to extend into rock a min. distance of 4'-0"
Bottom of ditch
SECTION D/13
SCALE: 1/8" = 1'-0"
TYPICAL SECTION AT EXPANSION JOINT
SCALE: 1" = 10'
2 coats of approved asphaltic emulsion
Upstream face
1" chamfer
SECTION E/13
SCALE: 1/4" = 1'-0"
NOTES:
Elevations refer to Mean Sea Level Datum.
See Sheet No. 14 for Spillway details.
All concrete on this sheet to be class B concrete and will be paid for under Item No. 32
Figures in hexagons indicate Item No. under which payment will be made
10/10/41 Drainage ditch and backfill added
10/29/40 Item numbers changed or removed
10-8-40 Spillway channels improved, sections added
5-8-40 Spillway increased 90' in length
KEY DATE REVISION (Indicated by △) REV.BY CK.BY AP.BY
CONNECTICUT RIVER FLOOD CONTROL
BIRCH HILL DAM
SPILLWAY
PLAN AND PROFILE
MILLERS RIVER MASSACHUSETTS
IN 49 SHEETS
SCALE 1" = 100'
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.
SUBMITTED
APPROVAL RECOMMENDED
APPROVED

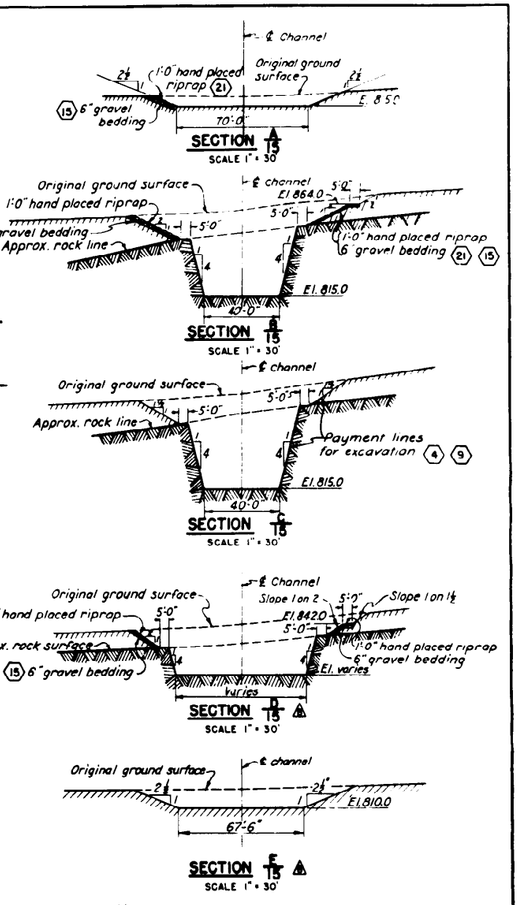
WAR DEPARTMENT

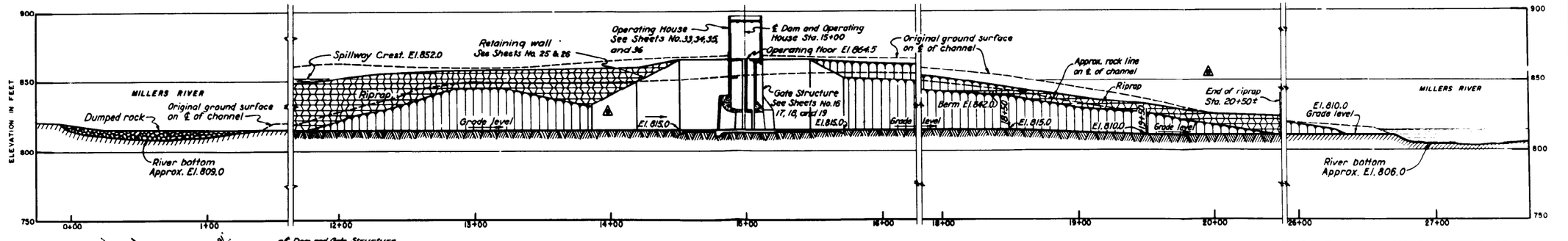
CORPS OF ENGINEERS, U. S. ARMY



PLAN

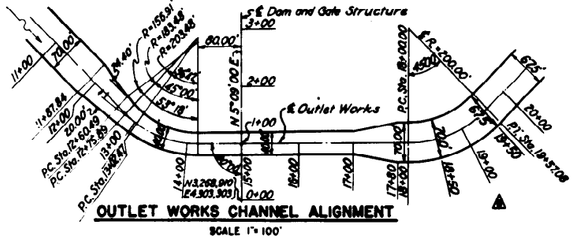
SCALE 1" = 100'





SECTION ON CENTER LINE OF CHANNEL

SCALE 1" = 30'



OUTLET WORKS CHANNEL ALIGNMENT

SCALE 1" = 100'

NOTES

All elevations refer to Mean Sea Level Datum.
Figures in hexagons indicate item numbers under which payment will be made.
For wall details see Sheets No. 25 and 26.
For gate structure details see Sheets No. 16, 17, 18, and 19.

RECORD DRAWINGS

KEY	DATE	REVISION (Indicated by Δ)	REV BY	CK BY	AP BY
2	5/14/41	Channel grade & width modified.	WAG	MW	MB
1	5/23/40	Slopes of dam modified	JH	IBL	TMB

CONNECTICUT RIVER FLOOD CONTROL

BIRCH HILL DAM
OUTLET WORKS
PLAN

MILLERS RIVER — MASSACHUSETTS

IN 50 SHEETS — SCALE 1 IN. = 100 FEET — SHEET NO. 15

U. S. ENGINEER OFFICE, PROVIDENCE, R. I. — JAN 1940

SUBMITTED: Thomas B. Larkin, SENIOR ENGINEER, HEAD, DESIGN SECTION

APPROVAL RECOMMENDED: D. D. Burns, PRINCIPAL ENGINEER, CHIEF, P. C. ENGINEERING DIV.

APPROVED: [illegible], [illegible] DIVISION ENGINEER

DESIGNED: J. Hartley, ASSOC. ENGINEER

DRAWN: J.T.B.D.W.C.

TRACED: E.C.B.

CHECKED: W.A.G.

FILE NO. [illegible]-1350

PLATE F-8

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY

PLAN
SCALE 1" = 100'

SECTION A/2
SCALE 1" = 50'

SECTION B/2
SCALE 1" = 50'

MAXIMUM SECTION THRU SPILLWAY WEIR
SCALE 1" = 10'

EMBANKMENT COFFERDAM
LOOKING UPSTREAM
SCALE 1" = 50'

SECTION THRU DAM AT STATION 24+50
SCALE 1" = 50'

DOWNSTREAM ELEVATION OF DAM
SCALE 1" = 80'

LEGEND

600 — Indicates contour

○ Indicates settlement gage for details see sheet No. 56

Approximate spoil area or stock pile area

NOTES

Elevations refer to Mean Sea Level Datum.
Contour interval is five feet except as shown.
For horizontal control see Sheet No. 66.

KEY	DATE	REVISION (indicated by △)	REV. BY	CK. BY	APP. BY
	Nov 1949	Final Field Corrections			
△	5 Oct 48	Parking area added, ducts revised, stone gutters & grouting deleted.	J.W.M.	H.P.	H.P.K.
△	6/20/47	Location of Utility Bldg revised and detour location revised	J.W.M.	J.B.K.	H.P.K.

DRAWINGS

CONNECTICUT RIVER FLOOD CONTROL

TULLY DAM

GENERAL PLAN

TULLY RIVER MASSACHUSETTS

IN 49 SHEETS SCALE 1 IN. = 100 FT. SHEET NO. 2

U. S. ENGINEER OFFICE, PROVIDENCE, R. I. OCTOBER 1944

SUBMITTED	APPROVAL RECOMMENDED	APPROVED
C. V. Murphy SENIOR ENGINEER PROJECT ENGINEER	H. P. Kinsey HEAD ENGINEER CHIEF, ENGINEERING DIV.	[illegible]

PREPARED: J. W. Hight, PROJECT UNIT NO. 2

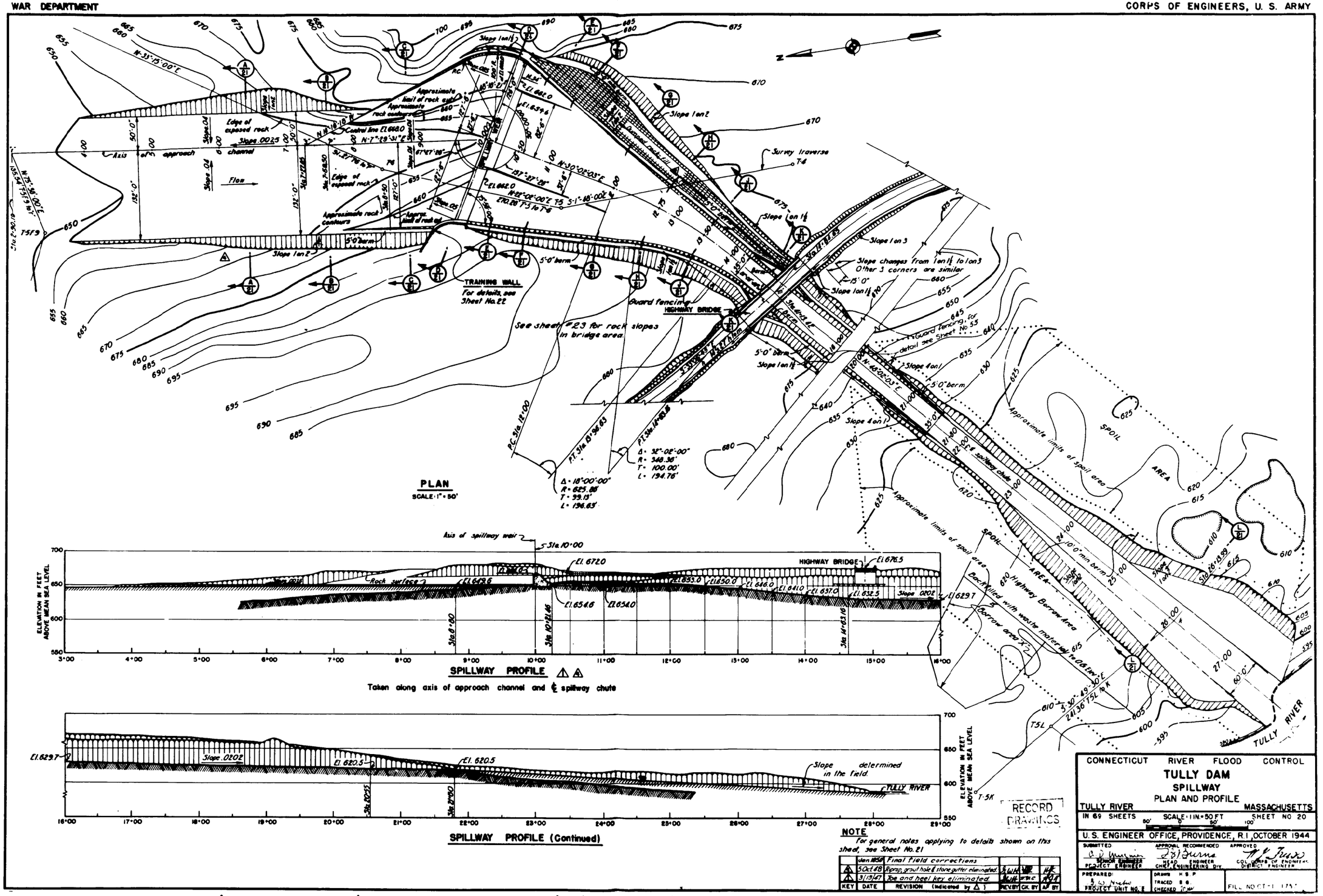
DRAWN: J. B. M.
TRACED: F. R. M.
CHECKED: J. B. K.

FILE NO. [illegible]

PLATE F-9

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY



PLAN
SCALE: 1" = 50'

SPILLWAY PROFILE ⚠ ⚠
Taken along axis of approach channel and ℄ spillway chute

SPILLWAY PROFILE (Continued)

NOTE
For general notes applying to details shown on this sheet, see Sheet No. 21

KEY	DATE	REVISION (Indicated by △)	REV'BY	CK. BY	AP. BY
	Jan 1954	Final Field corrections			
⚠	5 Oct 48	Riprap, grout hole & stone gutter eliminated	J.W.H.	W.C.	H.K.
⚠	3/13/47	Toe and heel key eliminated	J.W.H.	W.C.	H.K.

RECORD DRAWINGS

CONNECTICUT RIVER FLOOD CONTROL

TULLY DAM
SPILLWAY
PLAN AND PROFILE

TULLY RIVER MASSACHUSETTS

IN 69 SHEETS SCALE: 1 IN. = 50 FT SHEET NO 20

U. S. ENGINEER OFFICE, PROVIDENCE, R.I. OCTOBER 1944

SUBMITTED: C. P. Spencer, SENIOR ENGINEER, PROJECT ENGINEER
APPROVAL RECOMMENDED: [illegible], HEAD ENGINEERING DIV, CHIEF ENGINEERING DIV
APPROVED: [illegible], COL. CORPS OF ENGINEERS, DISTRICT ENGINEER

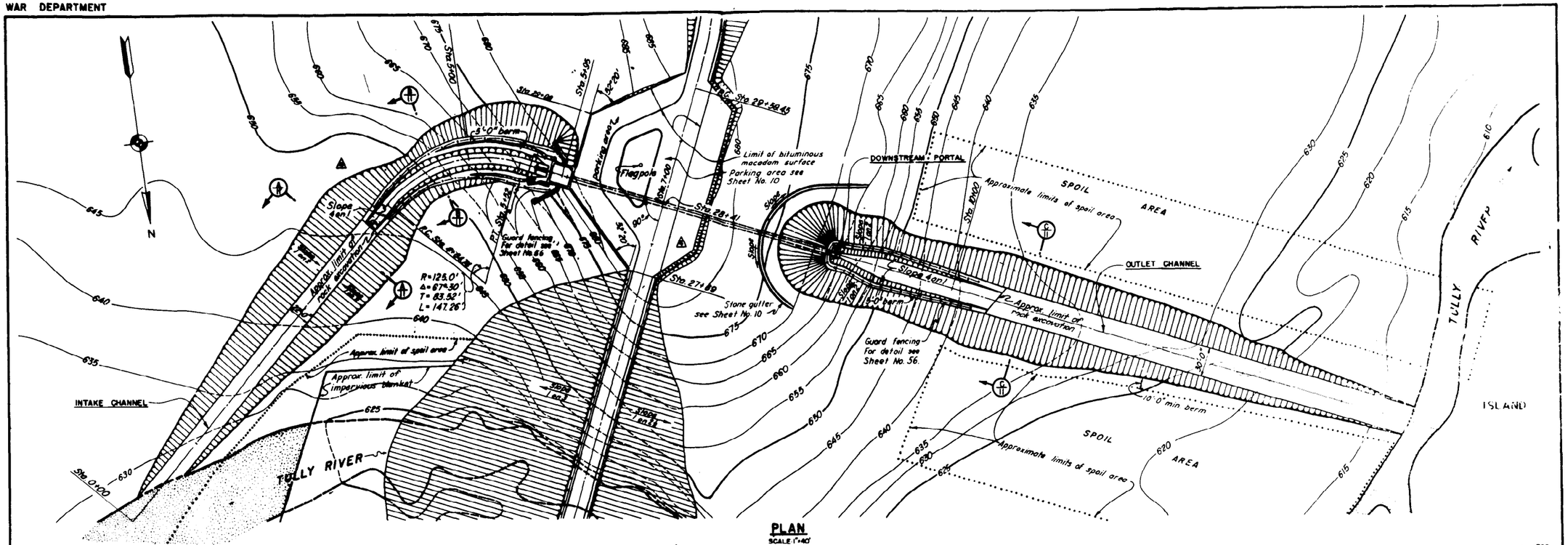
PREPARED: [illegible], PROJECT UNIT NO. E
DRAWN H. S. P.
TRACED S. G.
CHECKED [illegible]

FILE NO. CT-1-175.1

PLATE F-10

WAR DEPARTMENT

CORPS OF ENGINEERS, U S ARMY



NOTES

Elevations refer to Mean Sea Level Datum.
Contour interval 5 feet.
All expansion and construction joints in the tunnel shall have copper water stops.
Location, depth, inclination, and spacing of grout holes is tentative only and will be governed by conditions as disclosed during construction.
Figures in hexagons indicate items under which payment is made.
Concrete in the tunnel between Station 6+30.58 and Station 8+66.0 will be paid for under Item No. 55.
Rock excavation in the tunnel and transition between Station 6+03.5 and Station 8+77.5 will be paid for under Item No. 54.
Guard fencing to extend to a point where rock form is 2' above bottom of channel.

CONNECTICUT RIVER FLOOD CONTROL

TULLY DAM
OUTLET WORKS

TULLY RIVER MASSACHUSETTS

IN 69 SHEETS SCALE 1 IN = 40 FT (40' 0 40' 80) SHEET NO 11

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., APRIL, 1940

SUBMITTED: [illegible] SENIOR ENGINEER, HEAD, DESIGN SECTION
APPROVAL RECOMMENDED: [illegible] PRINCIPAL ENGINEER, CHIEF, E & C, NEW ENGLAND DIV.
APPROVED: [illegible] COLONEL, CORPS OF ENGINEERS, DIVISION ENGINEER
DESIGNED: A. D. MacSmith, ASSOC. ENGINEER
DRAWN: D. P.
TRACED: W. B. R.
CHECKED: [illegible]
FIL. NO. CT-11-1414

RECORD DRAWINGS

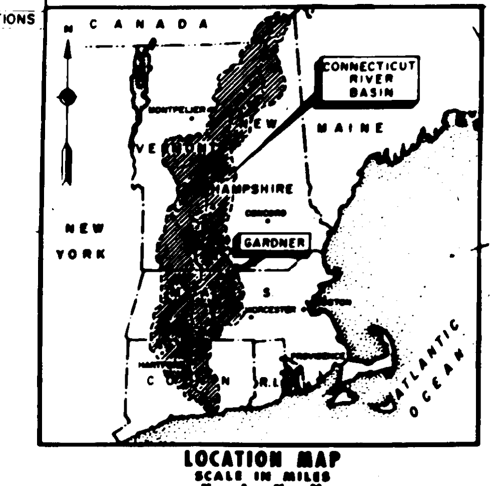
KEY	DATE	REVISION (indicated by △)	REV. BY	OK BY	AP BY
△	Nov. 1949	Final field corrections			
△	5 Oct 48	Parking area added, stone gutter deleted	AWR	WR	WR

△ △ △

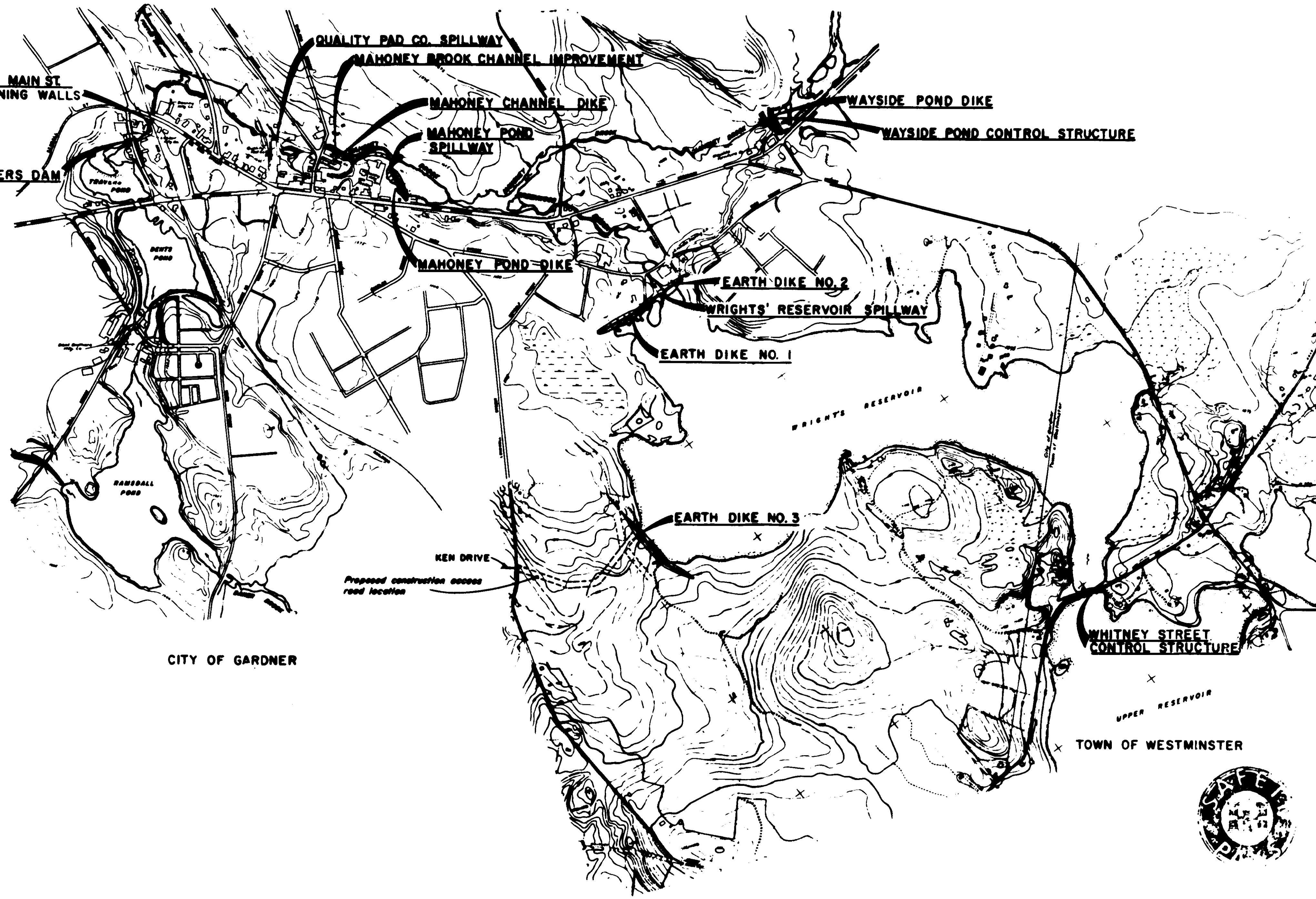
PLATE F-11

INDEX TO DRAWINGS (CONTINUED)

DRAWING NO.	SHEET NO.	TITLE
		DRAWINGS INCLUDED WITH SPECIFICATIONS
40-02-06	1 & 2	METAL BIN-TYPE RETAINING WALL
40-05-06	1 OF 1	SAFETY SIGN
STD-3		STANDARD STRUCTURAL JOINT DETAILS
SK-110		DETAIL OF SEEP RING
SK-111		DRAIN INLET
SK-112		PROCESS WATER INTAKE
⚠ 40-16-08		SAFETY FENCE & FABRIC STANDARD DETAILS
SK-129		SLUICE GATE STRUCTURE



LOCATION MAP
SCALE IN MILES



PROJECT PLAN
SCALE: 1" = 400'

INDEX TO DRAWINGS

DRAWING NO.	SHEET NO.	TITLE
CON-12	1	PROJECT PLAN AND INDEX
"	2	WRIGHTS RESERVOIR PLAN, PROFILES AND SECTIONS
"	3	WRIGHTS RESERVOIR SPILLWAY PLAN, DETAILS AND SECTIONS
	4	WHITNEY STREET CONTROL STRUCTURE AND DIKE NO. 3 PLANS, PROFILE AND SECTIONS
	5	WAYSIDE POND PLAN, DETAILS AND SECTIONS
	6	MAHONEY BROOK CHANNEL IMPROVEMENTS PLAN, PROFILE AND SECTIONS
	7	MAHONEY POND AND QUALITY PAD CO SPILLWAYS PLANS, DETAILS AND SECTIONS
"	8	SOUTH MAIN STREET RETAINING WALLS AND TRAVERS DAM PLANS AND SECTIONS
"	9	RECORD OF FOUNDATION EXPLORATIONS

(INDEX TO DRAWINGS CONTINUED ABOVE)

LEGEND

NEW	EXISTING	DESCRIPTION
● FD		FOUNDATION TEST BORING
● FP		FOUNDATION HAND PROBING
		BEDROCK OUTCROP
—W—		WATER LINE
G.V.		GATE VALVE
		SLUICE TO DRAIN
		SANITARY SEWER LINE AND MANHOLE
		[illegible]
		[illegible]
		[illegible]
		[illegible]
		[illegible]
▼▼▼		[illegible]
		[illegible]
		[illegible]
		[illegible]
▼▼▼		ROCK CUT

Record Drawing
Contract No. 65-3

		Final field corrections
⚠	8-27-64	[illegible]

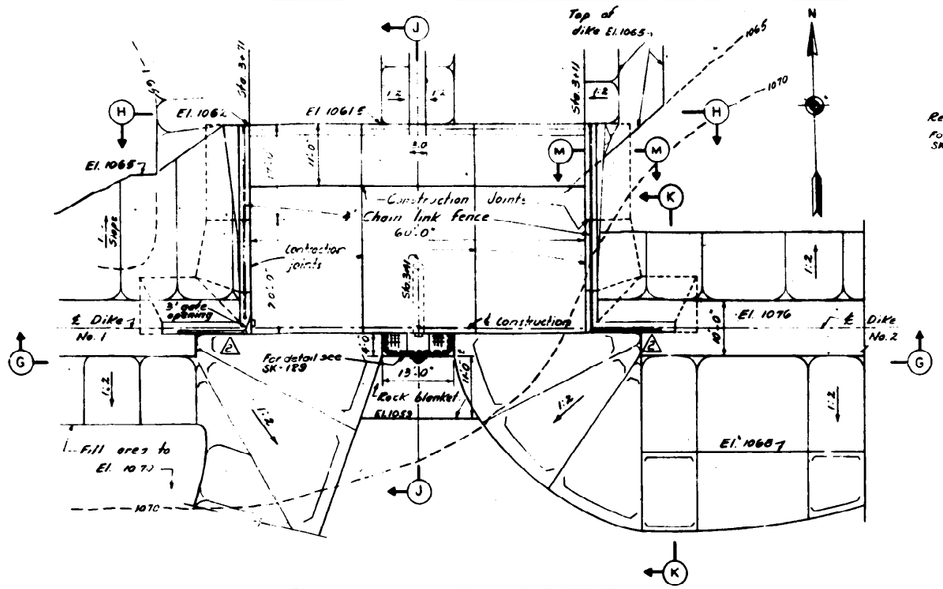
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

C.W.H. J.B.L.

CONNECTICUT RIVER FLOOD CONTROL
GARDNER LOCAL PROTECTION
PROJECT PLAN AND INDEX
MAHONEY AND GREENWOOD BROOKS MASS
MAY 1964

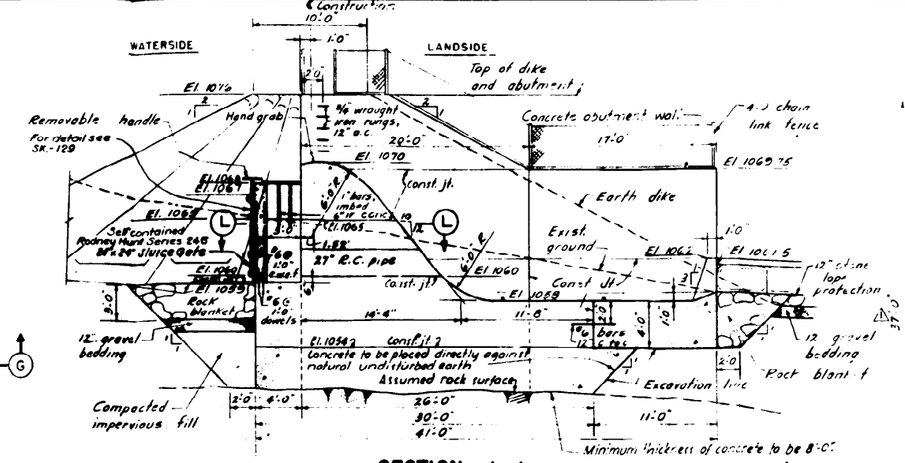
CON-12
SHEET 1

PLATE F-12



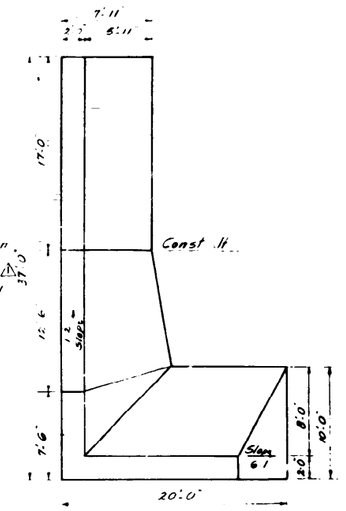
PLAN OF WRIGHTS RESERVOIR SPILLWAY

SCALE: 1"=10'



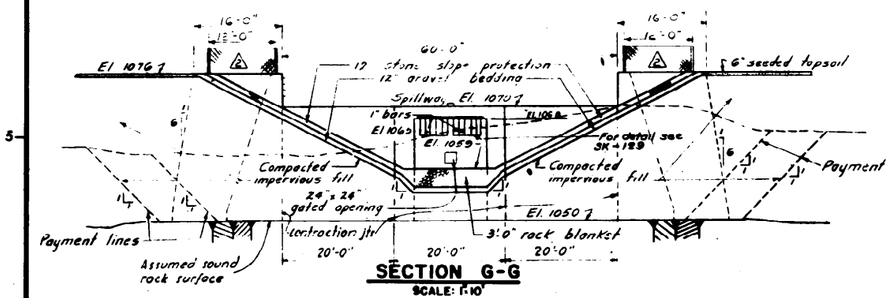
SECTION J-J

SCALE 1"=5'



PLAN OF RIGHT ABUTMENT

SCALE 1"=5'

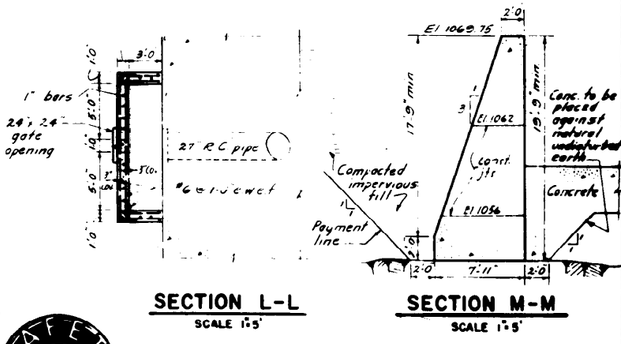


SECTION G-G

SCALE: 1"=10'

SECTION K-K

SCALE 1"=10'

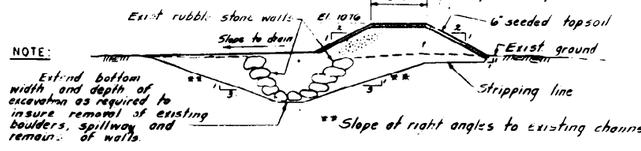


SECTION L-L

SCALE 1"=5'

SECTION M-M

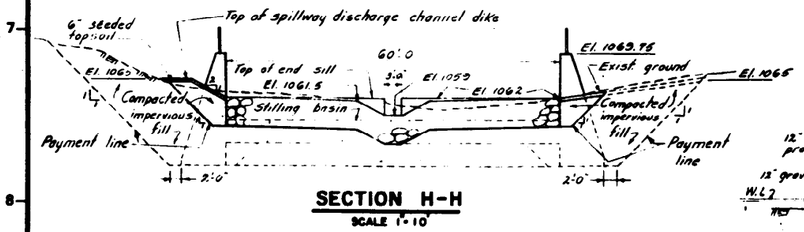
SCALE 1"=5'



SECTION (C/2)

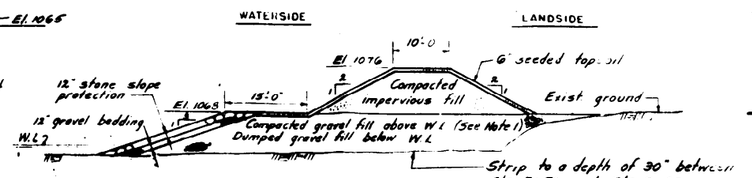
(TYPICAL FROM STA. 3+87 TO STA. 5+30)

SCALE 1"=10'



SECTION H-H

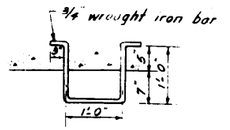
SCALE 1"=10'



SECTION (C/2)

(TYPICAL FROM STA. 5+30 TO STA. 9+20)

SCALE 1"=10'



PLAN OF WROUGHT IRON RUNG

(8 REQUIRED)

SCALE 1"=1'

Record Drawing

65-3

NOTES:

1. W.L. indicates water line at time of construction.
2. [illegible] to W.L. [illegible]

REVISION	DATE	DESCRIPTION
		final field corrections
	4-14-64	[illegible] added
1	8-21-64	Dimension revised (Am. #1)

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY C.W.H. | DR. BY C.W.A. | CK. BY [illegible]

CONNECTICUT RIVER FLOOD CONTROL
GARDNER LOCAL PROTECTION
WRIGHTS RESERVOIR SPILLWAY
PLAN, DETAILS AND SECTIONS

MAHONEY AND GREENWOOD BROOKS MASS.

APPROVED [signature] DATE MAY 1964

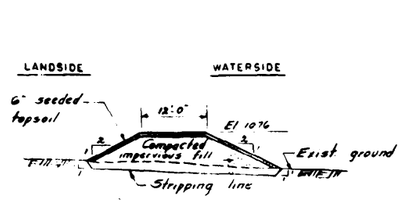
SCALE AS SHOWN | SPEC. NO. CIV. ENG. 10-065-64-68

CON-12

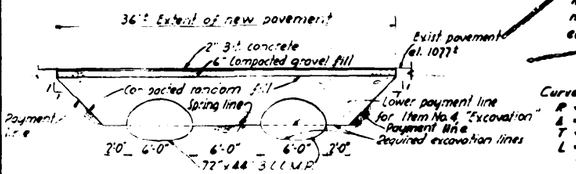
SHEET 3

PLATE F-13

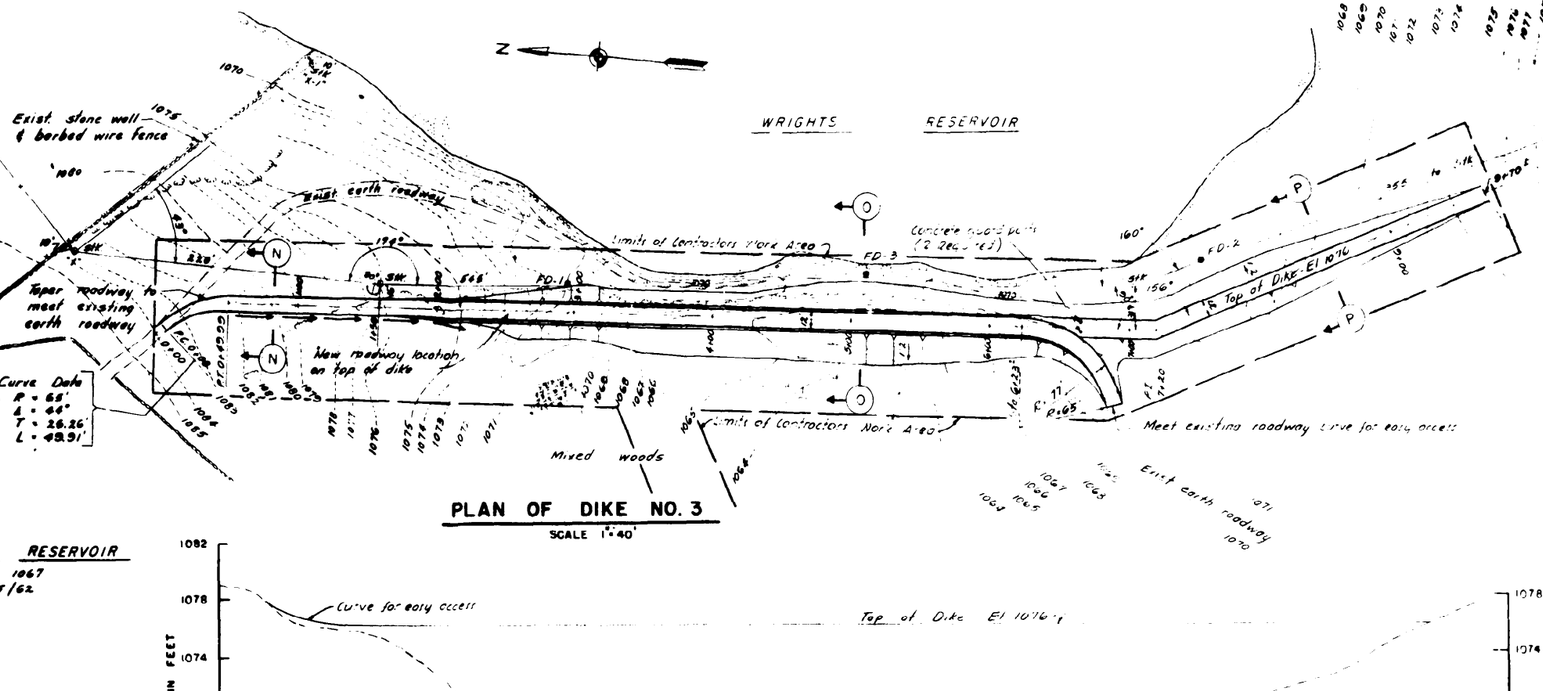
CORPS OF ENGINEERS — U. S. ARMY



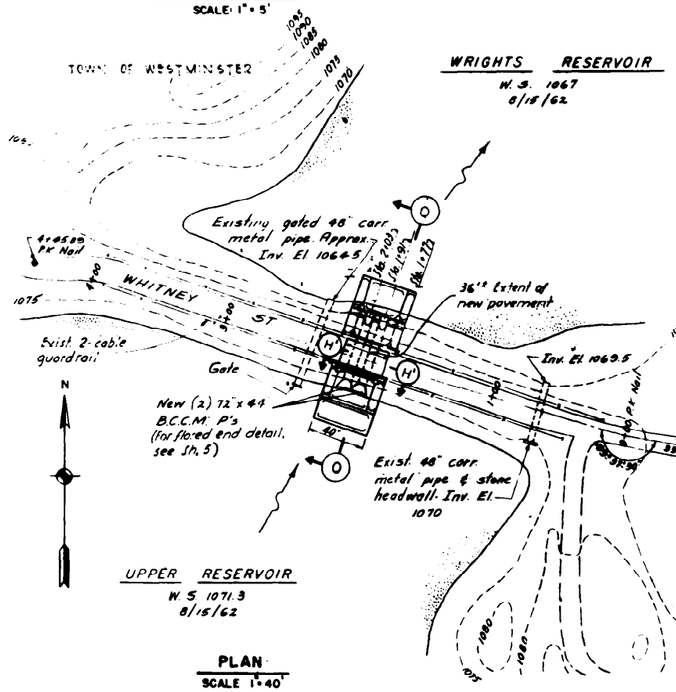
SECTION P-P
(TYPICAL FROM STA. 6+65 TO STA. 9+70)
SCALE 1" = 10'



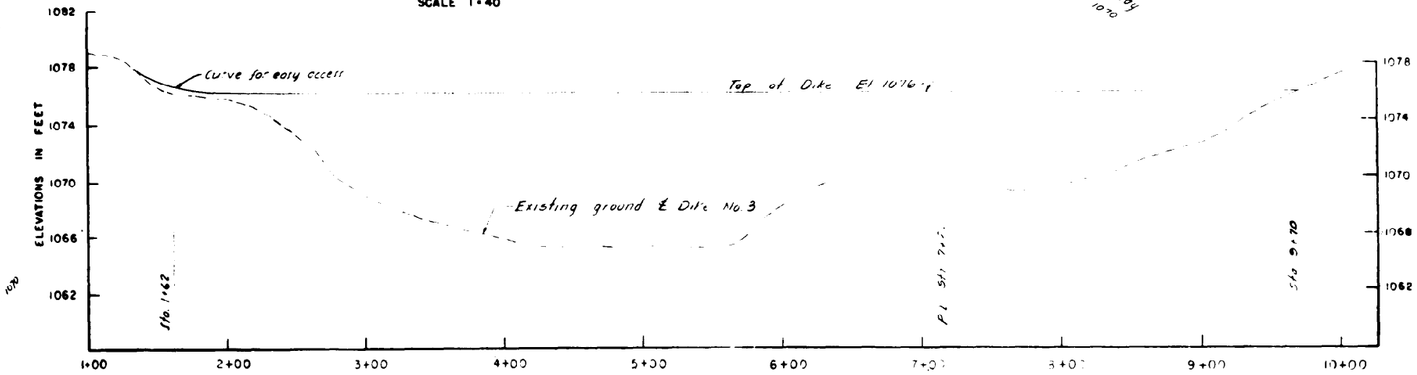
SECTION H'-H'
SCALE: 1" = 5'



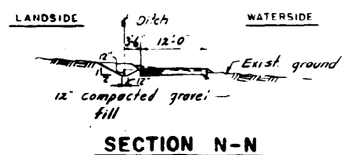
PLAN OF DIKE NO. 3
SCALE 1" = 40'



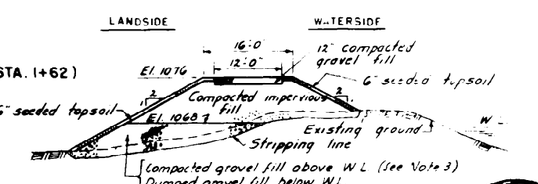
PLAN
SCALE 1" = 40'



PROFILE ALONG ℄ OF DIKE NO. 3
SCALE: HOR. 1" = 40'
VERT. 1" = 4'

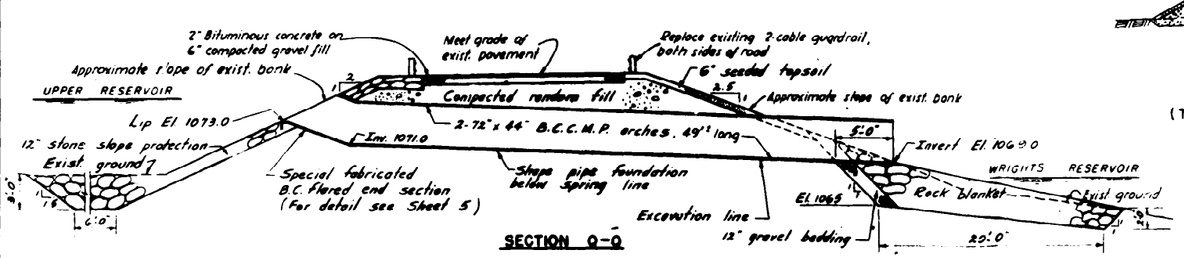


SECTION N-N
(TYPICAL FROM STA. 0+00 TO STA. 1+62)
SCALE 1" = 10'



SECTION O-O
(TYPICAL FROM STA. 1+62 TO STA. 6+23)
SCALE 1" = 10'

NOTES:
1. Ramp construction of approximate Sta. 6+50 similar except for top elevation and width of shoulders.
2. Provide transition from Sta. 6+23 to Sta. 6+65



SECTION O-O
WHITNEY ST. CONTROL STRUCTURE
SCALE 1" = 5'

SAFETY PAYS

Record Drawing
Contract No. DA-19-015-CIV ENG. 65-3

NOTES:
1. Elevations refer to Mean Sea Level Datum
2. For Record of Foundation Explorations see Sheet 3.
3. W.L. indicates water line at time of construction

Revision	Date	Description	By
	3-16-64	Final field corrections	

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY P.W.S. | DR. BY C.M.A. | CK. BY

CONNECTICUT RIVER FLOOD CONTROL
GARDNER LOCAL PROTECTION
WHITNEY STREET CONTROL STRUCTURE AND DIKE NO. 3
PLANS, PROFILE AND SECTIONS
MAHONEY AND GREENWOOD BROOKS MASS.

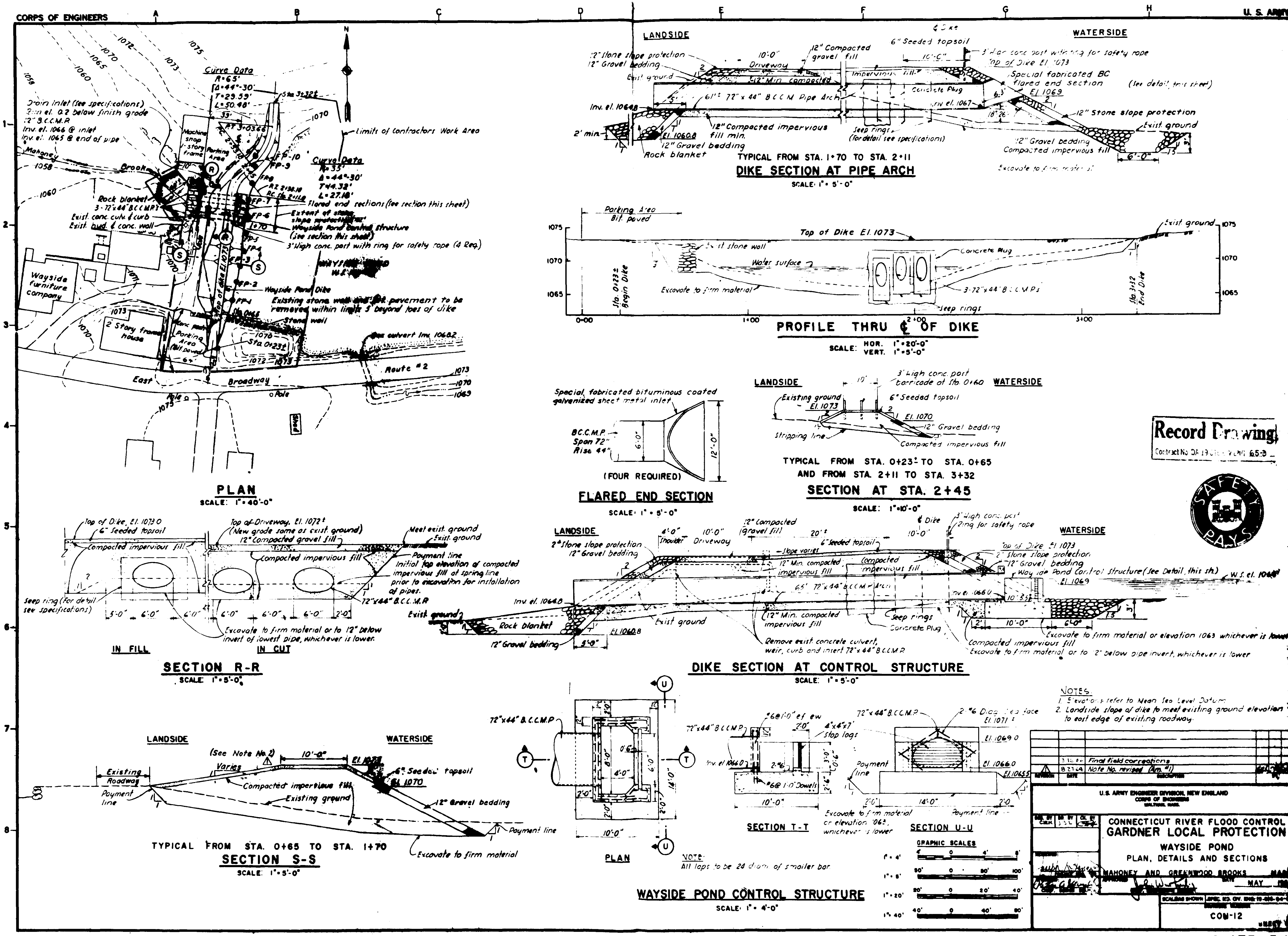
APPROVED _____ DATE MAY 1964

SCALE AS SHOWN | SPEC. NO. CIV. ENG. 1-016-64-65

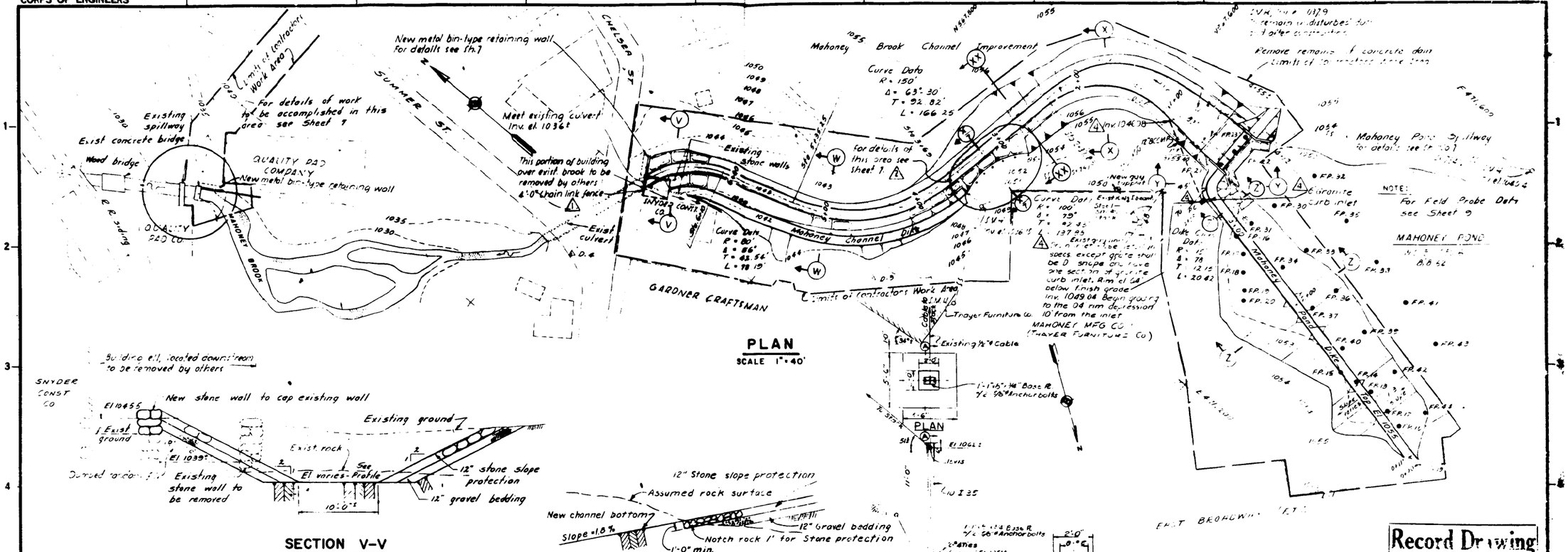
DRAWING NUMBER
CON-12

SHEET 4

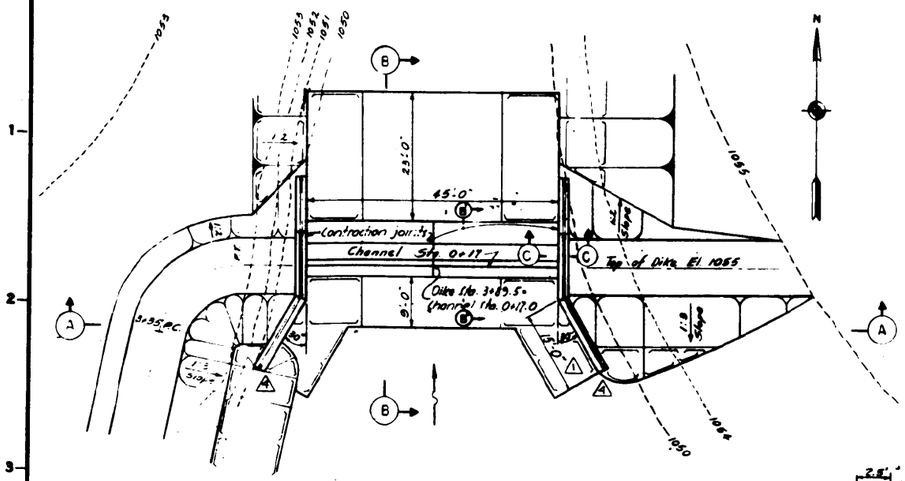
PLATE F-14


CORPS OF ENGINEERS
U. S. ARMY
PLAN
SCALE: 1" = 40'-0"
Curve Data
R = 65'
Δ = 44°-30'
T = 29.59'
L = 50.48'
Curve Data
R = 35'
Δ = 44°-30'
T = 14.32'
L = 27.18'
Limits of Contractors Work Area
Drain inlet (See specifications)
12" B.C.C.M.P.
Inv. el. 1066 @ inlet
Inv. el. 1065 @ end of pipe
Mahoney Brook
Rock blanket
3-72"x44" B.C.C.M.P.'s
Flared end sections (see section this sheet)
Wayside Pond Control Structure (see section this sheet)
3' High conc. post with ring for safety rope (4 Req.)
Wayside Furniture Company
2 Story frame house
Machine shop 1-Story frame
Parking Area
Wayside Pond Dike
Existing stone wall and bit. pavement to be removed within limits 5' beyond toes of dike
Stone wall
Box culvert Inv. 1068.2
Route #2
East Broadway
DIKE SECTION AT PIPE ARCH
SCALE: 1" = 5'-0"
LANDSIDE
WATERSIDE
12" Stone slope protection
12" Gravel bedding
12" Compacted gravel fill
6" Seeded topsoil
Top of Dike El. 1073
Special fabricated BC flared end section (see detail this sheet)
61'± 72" x 44" B.C.C.M. Pipe Arch
12" Compacted impervious fill min.
Seep rings (for detail see specifications)
Rock blanket
TYPICAL FROM STA. 1+70 TO STA. 2+11
PROFILE THRU ℄ OF DIKE
SCALE: HOR. 1" = 20'-0" VERT. 1" = 5'-0"
Parking Area Bit. paved
Top of Dike El. 1073
Exist. ground
Exist. stone wall
Water surface
Concrete Plug
3-72"x44" B.C.C.M.P.s
Excavate to firm material
Seep rings
Sta. 0+23± Begin Dike
Sta. 3+32 End Dike
FLARED END SECTION
SCALE: 1" = 5'-0"
Special fabricated bituminous coated galvanized sheet metal inlet
B.C.C.M.P. Span 72" Rise 44"
(FOUR REQUIRED)
SECTION AT STA. 2+45
SCALE: 1" = 10'-0"
TYPICAL FROM STA. 0+23± TO STA. 0+65 AND FROM STA. 2+11 TO STA. 3+32
3' High conc. post barricade at Sta. 0+60
Existing ground El. 1073
Stripping line
Compacted impervious fill
Record Drawing
SAFETY PAYS
SECTION R-R
SCALE: 1" = 5'-0"
IN FILL
IN CUT
Top of Dike, El. 1073.0
Top of Driveway, El. 1072± (New grade same as exist. ground)
Payment line
Initial top elevation of compacted impervious fill at spring line prior to excavation for installation of pipes.
Excavate to firm material or to 12" below invert of lowest pipe, whichever is lower.
DIKE SECTION AT CONTROL STRUCTURE
SCALE: 1" = 5'-0"
Remove exist. concrete culvert, weir, curb and insert 72"x44" B.C.C.M.P.
Excavate to firm material or elevation 1063 whichever is lower
Excavate to firm material or to 12" below pipe invert, whichever is lower
SECTION S-S
SCALE: 1" = 5'-0"
TYPICAL FROM STA. 0+65 TO STA. 1+70
Existing Roadway
Compacted impervious fill
Existing ground
12" Gravel bedding
Excavate to firm material
WAYSIDE POND CONTROL STRUCTURE
SCALE: 1" = 4'-0"
PLAN
SECTION T-T
SECTION U-U
NOTE: All laps to be 24 diam. of smaller bar
NOTES
1. Elevations refer to Mean Sea Level Datum
2. Landside slope of dike to meet existing ground elevation to east edge of existing roadway.
Final field corrections
Note No. revised (Am. #1)
GRAPHIC SCALES
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
CONNECTICUT RIVER FLOOD CONTROL
GARDNER LOCAL PROTECTION
WAYSIDE POND
PLAN, DETAILS AND SECTIONS
MAHONEY AND GREENWOOD BROOKS
MAY 1964
CON-12

CORPS OF ENGINEERS — U. S. ARMY

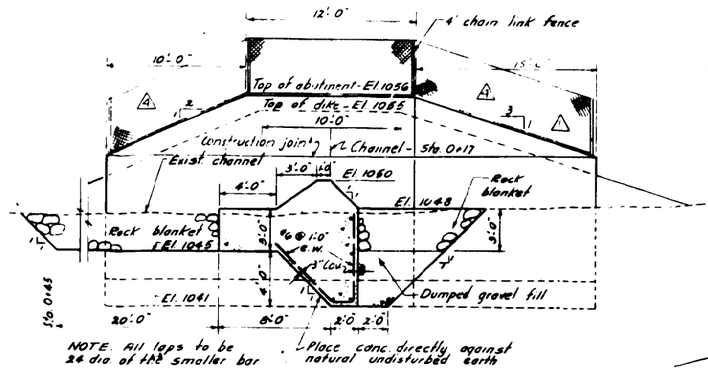


CORPS OF ENGINEERS — U. S. ARMY



PLAN OF MAHONEY POND SPILLWAY

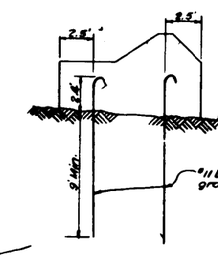
SCALE: 1" = 10'

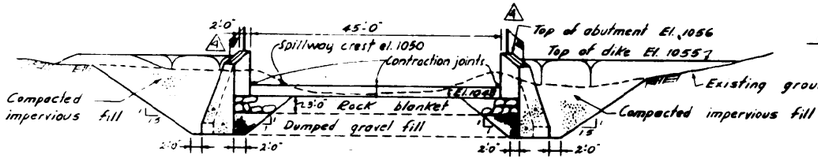


NOTE. All laps to be 24 dia. of the smaller bar. Place conc. directly against natural undisturbed earth

SECTION B-B

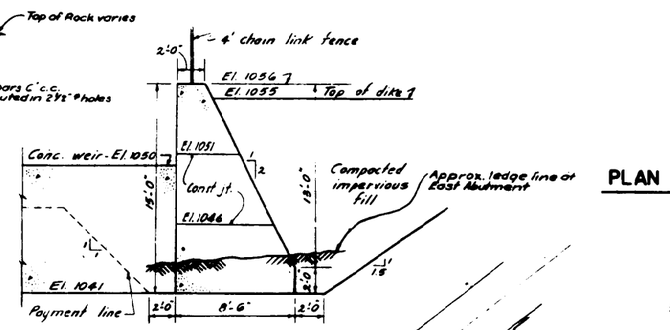
SCALE: 1" = 4'





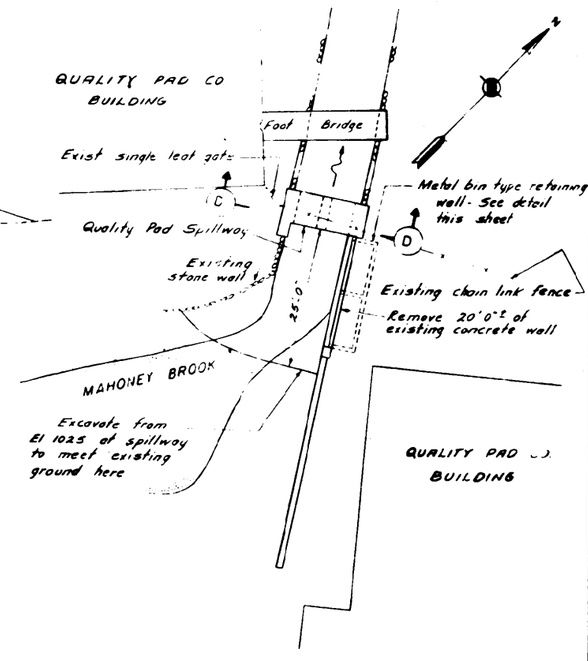
SECTION A-A

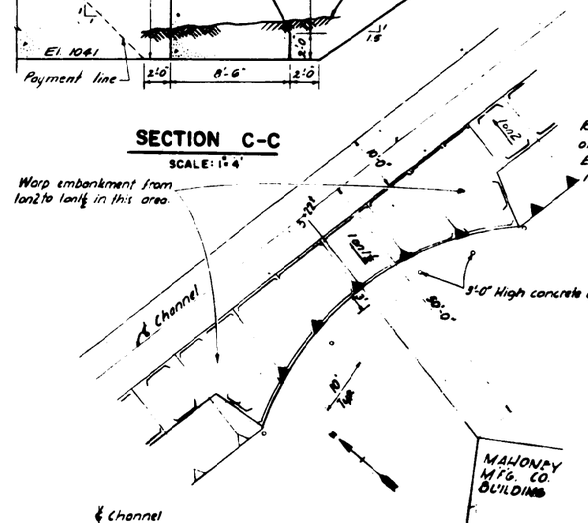
SCALE: 1" = 10'



PLAN OF QUALITY PAD CO. SPILLWAY

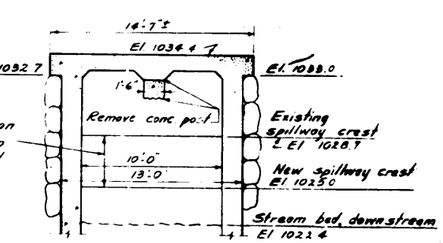
SCALE: 1" = 10'





SECTION C-C

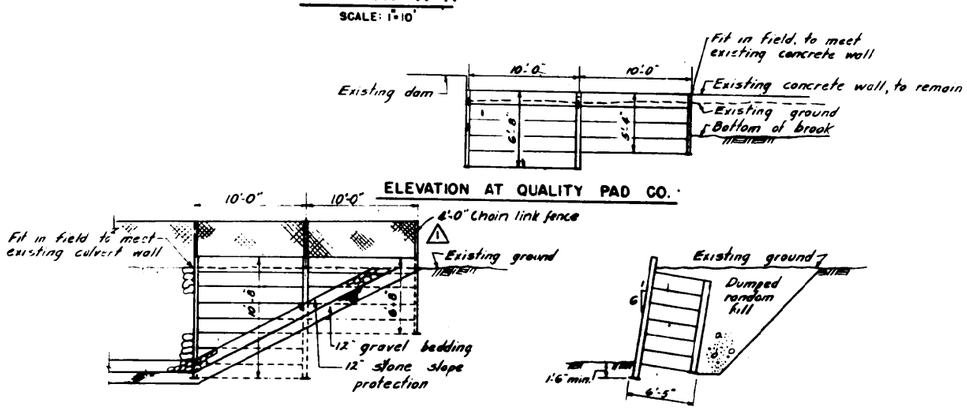
SCALE: 1" = 4'



SECTION D-D

SCALE: 1" = 4'

Note:
Elevations refer to Mean Sea Level Datum



ELEVATION AT QUALITY PAD CO.

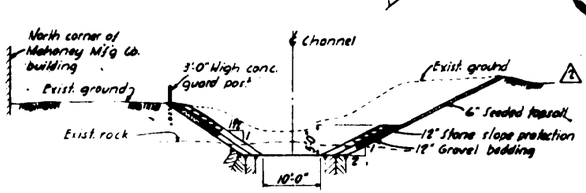
ELEVATION AT CHELSEA ST.

END VIEW

METAL BIN TYPE RETAINING WALL

(FOR DETAILS, SEE SPECIFICATIONS)

SCALE: 1" = 5'



PLAN OF MAHONEY BROOK AT MAHONEY M'F'G. CO.

SCALE: 1" = 10'

SECTION

SCALE: 1" = 10'

4	7-26	Final field corrections	
3	7-14-65	Fence added	
2	10-16-64	Section revised	
1	8-29-64	Plan and section added.	
	6/18/64	Fence note & dimension added, section revised	
REVISIONS	DATE	DESCRIPTION	

Record Drawing

Contract No. DA-19-065-CIVENG-64-3

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

CONNECTICUT RIVER FLOOD CONTROL
GARDNER LOCAL PROTECTION
MAHONEY POND AND QUALITY PAD CO. SPILLWAYS
PLANS, DETAILS AND SECTIONS
MAHONEY AND GREENWOOD BROOKS MASS.

DES. BR. CHIEF | DR. BR. CHIEF | CH. OF DIV.
APPROVED
DATE MAY 1964
SCALE AS SHOWN SPEC. NO. CIV. ENG. NO. 65-64-12

CON-12
SHEET 7

PLATE F-17

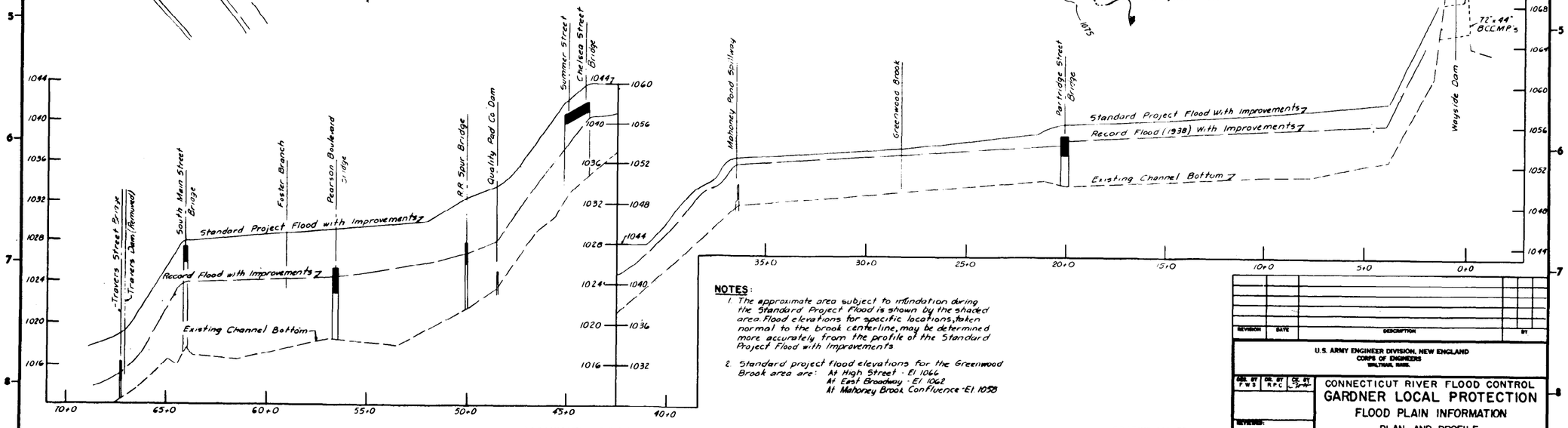
CORPS OF ENGINEERS — U. S. ARMY

Approximate Flood Plain Limit (Channel line)
Standard Project Flood with Improvements

WAYSIDE POND CONTROL STRUCTURE
WAYSIDE POND DIKE
QUALITY PAD CO. SPILLWAY
MAHONEY CHANNEL DIKE
MAHONEY BROOK CHANNEL IMPROVEMENT
MAHONEY POND SPILLWAY
SOUTH MAIN ST. RETAINING WALLS
TRAVERS DAM
MAHONEY POND DIKE
EARTH DIKE NO. 2
WRIGHTS RESERVOIR SPILLWAY
EARTH DIKE NO. 1

Pearson Boulevard
Foster Branch Ditch
Summer Street
Chelsea Street
Partridge Street
Mahoney Brook
Minott St.
Broadway
East Greenwood Brook
Hewston St.
South Main Street
Travers St.
Travers Pond
Bassett & Nice
Knight St.
Route 2A
Railroad
West Broadway
Bents Pond
High St.
Prospect St.
Mahoney Pond
Wrights Reservoir
Wayside Pond

PLAN
SCALE 1" = 200'



MAHONEY BROOK PROFILE
SCALE: 1" = 200' HOR
1" = 4' VERT

NOTES:
1. The approximate area subject to inundation during the Standard Project Flood is shown by the shaded area. Flood elevations for specific locations, taken normal to the brook centerline, may be determined more accurately from the profile of the Standard Project Flood with Improvements.
2. Standard project flood elevations for the Greenwood Brook area are: At High Street - El 1066
At East Broadway - El 1062
At Mahoney Brook Confluence - El 1058

GRAPHIC SCALES
1" = 4'
1" = 200'

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY FWS | DR. BY RPC | CK. BY

REVIEWED: C.N. Cavella, PROJECT ENGINEER
CHIEF, DESIGN BRANCH

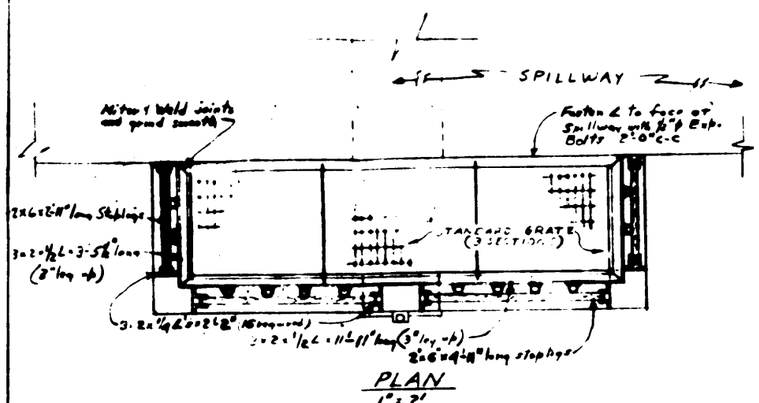
CONNECTICUT RIVER FLOOD CONTROL
GARDNER LOCAL PROTECTION
FLOOD PLAIN INFORMATION
PLAN AND PROFILE
MAHONEY AND GREENWOOD BROOKS MASS.

APPROVED: DATE MARCH 1966
CHIEF, ENGINEERING DIVISION

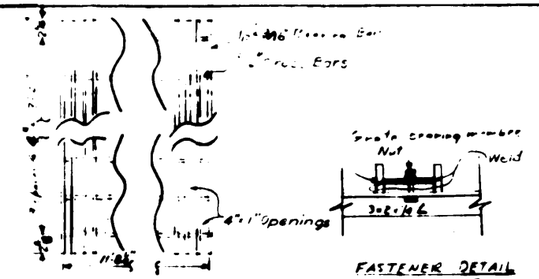
SCALE | SPEC. NO. CIV. ENG. 19-018-
DRAWING NUMBER
CON-50
SHEET 10

PLATE F-18

WRIGHTS RESERVOIR

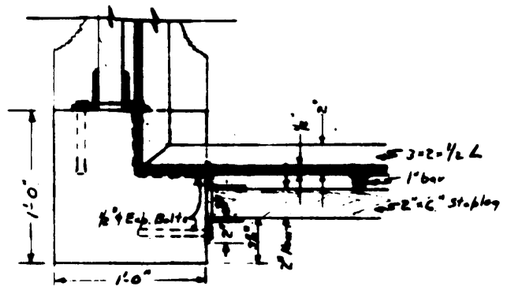


PLAN
1" = 2'

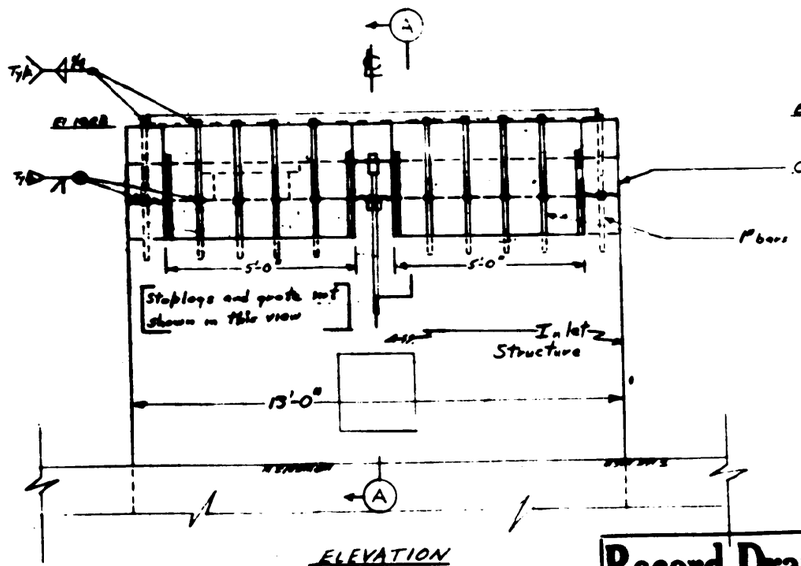


GRATE PLAN
NO SCALE

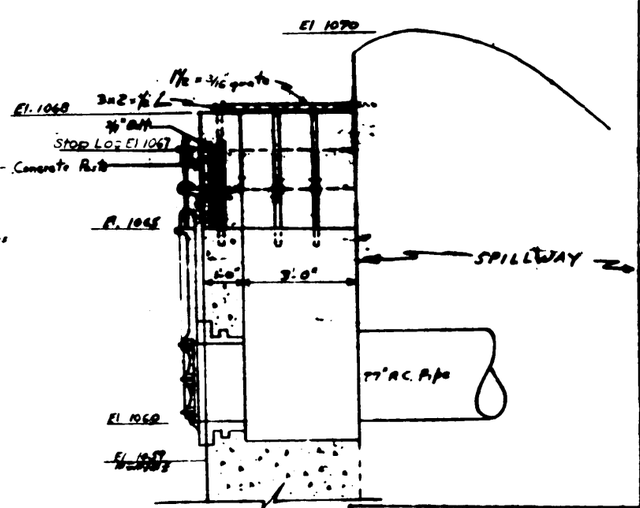
FASTENER DETAIL
NO SCALE
Use 2 fasteners on each grate section



PLAN OF POST DETAIL
1" = ½'



ELEVATION
1" = 2'



SECTION A-A
1" = 2'

Record Drawing
Contract No. D[illegible]ENG 6.5-3

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

GARDNER LOCAL PROTECTION
SLUICE GATE STRUCTURE
PLAN ELEVATION SECTION & DETAIL
SK-129 DATE JULY 1965

PLATE F-19

CORPS OF ENGINEERS

U. S ARMY

SEAMAN PAPER CO. ID.

BALDWINVILLE S.T.P.

GARDNER - TEMPLETON S.T.P.

WINCHENDON S.T.P.

BALDWINVILLE PRODUCTS I.D.

SOUTH ROYALSTON S.T.P.

BIRCH HILL RESERVOIR FLOW LINE AT SPILLWAY CREST EL. 852.0' M.S.L.

MILLERS RIVER INTAKE

8' DIA. TUNNEL

10' DIA. TUNNEL

TULLY LAKE FLOW LINE AT SPILLWAY CREST EL. 668.0' M.S.L.

TULLY INTAKE

TUNNEL OUTLET

POSSIBLE TUNNEL EXTENSION TO WEST BRANCH QUABBIN RESERVOIR

NORTHFIELD MT PROJECT

RINDGE

JAFFREY

FITZWILLIAM

WINCHENDON

BALDWINVILLE

TEMPLETON

HUBBARDSTON

BARRE

ROYALSTON

PHILLIPSTON

PETERSHAM

HARDWICK

ATHOL

RICHMOND

ORANGE

WARWICK

ERVING

WENDELL

NEW SALEM

SHUTESBURY

PELHAM

BELCHERTOWN

WARE

LOCATION MAP
SCALE 1" = 14 MILES APPROX

LEGEND
- PRECIPITATION - RECORDING
- PRECIPITATION - NON-RECORDING
- STREAM GAGING - RECORDING
- SNOW COURSES
- BASIN DIVIDE
- S.T.P. - SEWAGE TREATMENT PLANT
- I.D. - INDUSTRIAL DISCHARGE

GRAPHIC SCALES
1" = 1 MILE

NORTHEASTERN UNITED STATES
WATER SUPPLY STUDY

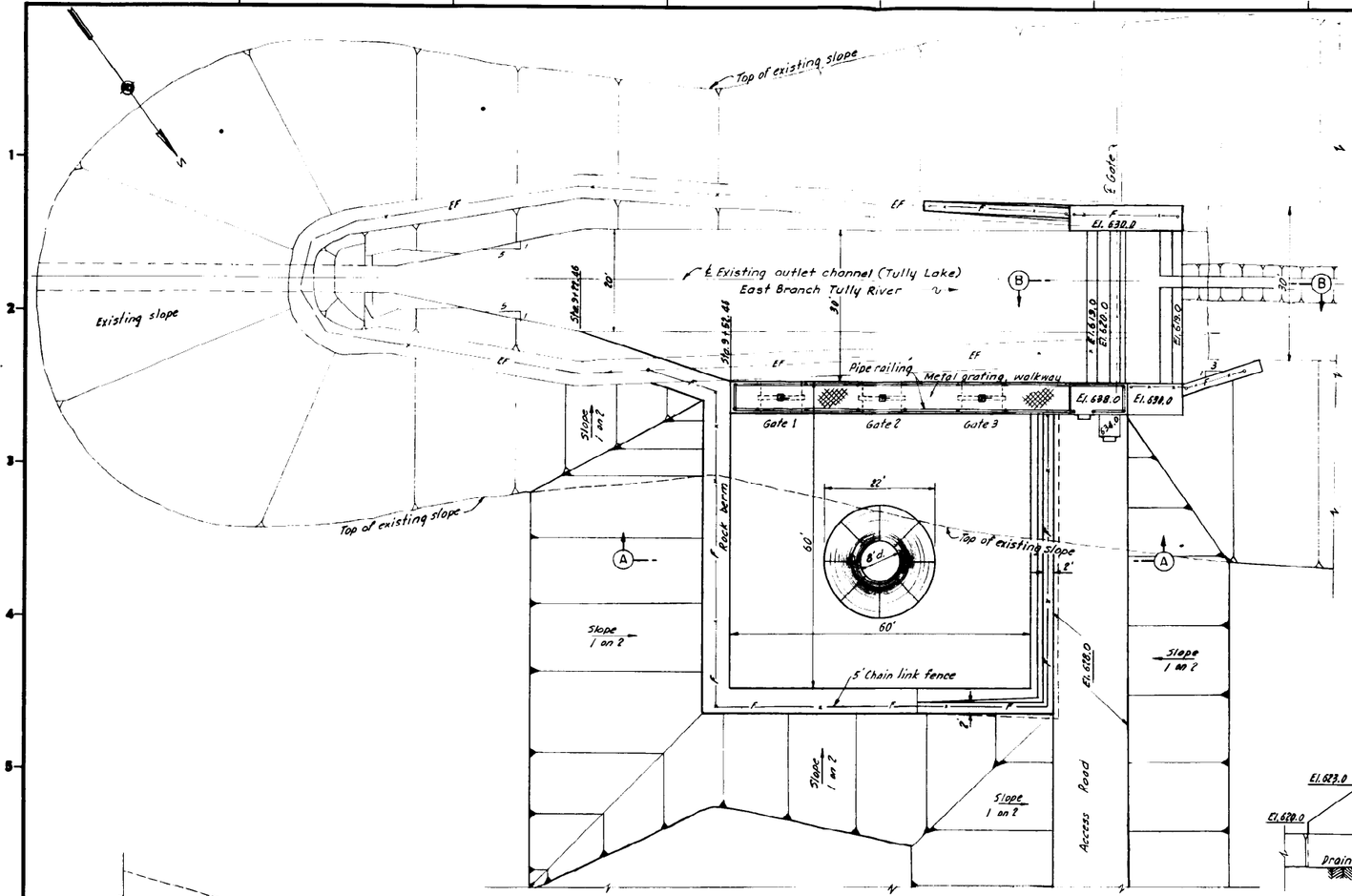
TULLY - MILLERS DIVERSION
ALTERNATIVE NO. 2

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORP OF ENGINEERS
WALTAM, MASS.

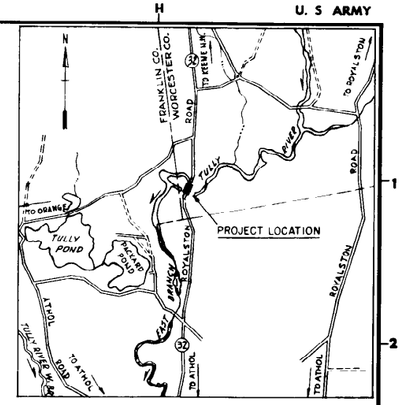
PLATE F-20

CORPS OF ENGINEERS

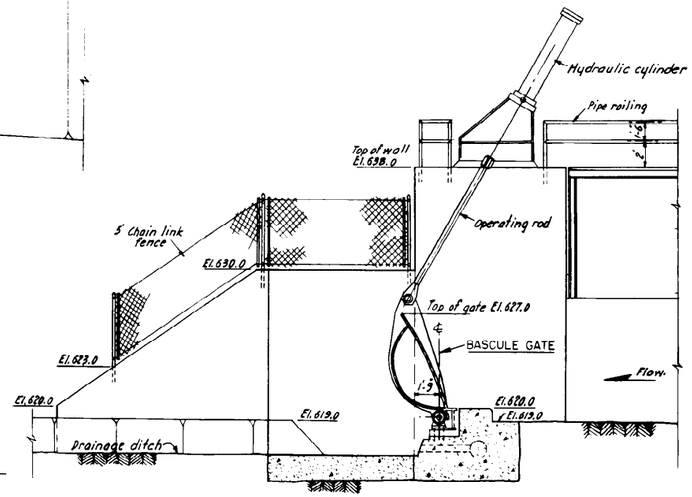
U. S ARMY



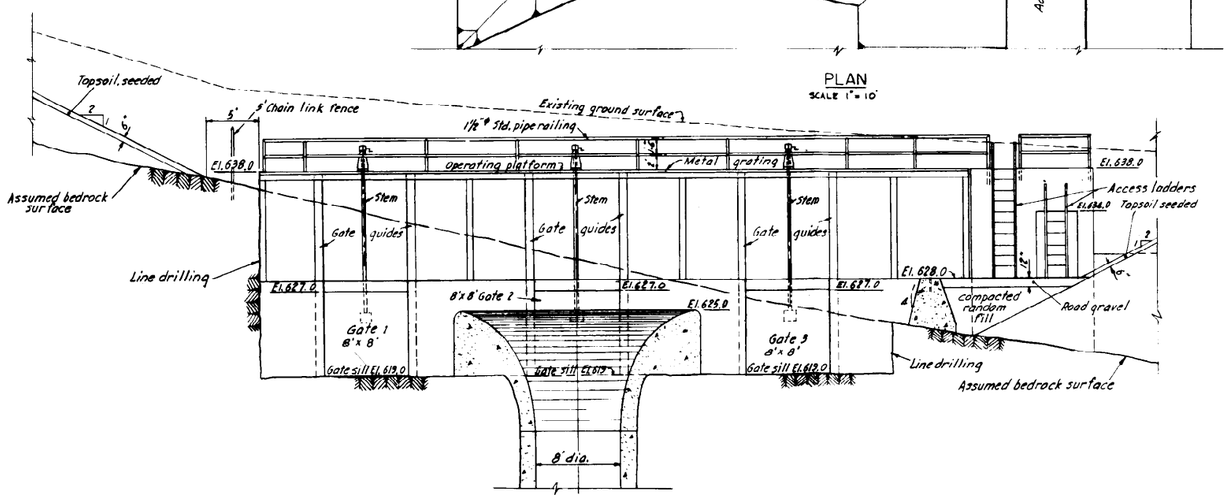
PLAN
SCALE 1" = 10'



LOCATION MAP
2000' 0 2000' 4000 Ft.



SECTION B-B
SCALE 1/4" = 1'-0"



SECTION A-A
SCALE 1" = 5'

GRAPHIC SCALES
1" = 10'
1" = 5'
1/4" = 1'-0"

NOTES

Elevations refer to Mean Sea Level Datum.

NORTHEASTERN UNITED STATES
WATER SUPPLY STUDY

EAST BRANCH TULLY RIVER
TUNNEL INLET STRUCTURE

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

PLATE F-21

WATER CONTROL BRANCH
S. COOPER, CHIEF

RESERVOIR CONTROL CENTER
J. FINEGAN, CHIEF

HOUSATONIC RIVER BASIN
R.W. MIRICK, BASIN REGULATOR

- THOMASTON DAM
  A. HOFFMAN, PROJ. MGR.
  R.M. HOWE, ASSISTANT
- HALL MEADOW BROOK DAM *
- EAST BRANCH DAM *
- NORTHFIELD BROOK LAKE
- HANCOCK BROOK LAKE
- HOP BROOK LAKE
  L. WILLIAMS, PROJ. MGR.
  J. DELONG, ASSISTANT
- BLACK ROCK LAKE
  E.W. FOSTER, PROJ. MGR.
  T. COLLINS, ASSISTANT

CONNECTICUT RIVER BASIN
J.W. FINEGAN, BASIN REGULATOR

- UNION VILLAGE DAM
  R. THRESHER, PROJ. MGR.
  J. FARRELL, ASSISTANT
- NORTH HARTLAND LAKE
  J.W. WARD, PROJ. MGR.
  J. DYER, ASSISTANT
- NORTH SPRINGFIELD LAKE
  E.P. MORSE, PROJ. MGR.
  R. WITHINGTON, ASSISTANT
- BALL MOUNTAIN LAKE
  H.C. LOBDELL, PROJ. MGR.
  R. SNOW, ASSISTANT
- TOWNSHEND LAKE
  R. BALLANTINE, PROJ. MGR.
  N. GOODENOUGH, ASSIST.
- SURRY MOUNTAIN LAKE
  V. GUYETTE, PROJ. MGR.
  R. EVERY, ASSISTANT
- OTTER BROOK LAKE
  J. BOYEA, PROJ. MGR.
  D. SHEPARDSON, ASSISTANT
- BIRCH HILL DAM
  J. BACON, PROJ. MGR.
  C. SABINE, ASSISTANT
- TULLY LAKE
  R.A. PARKER, PROJ. MGR.
  ASSISTANT
- BARRE FALLS DAM
  L. BURGESS, PROJ. MGR.
  ASSISTANT
- CONANT BROOK DAM
- LITTLEVILLE LAKE
  J. PARKER, PROJ. MGR.
  M. CAPUTO, ASSISTANT
- KNIGHTVILLE DAM
  L.W. LAFOND, PROJ. MGR.
  J. JOHNSON, ASSISTANT
- COLEBROOK RIVER LAKE
  P.R. LEWIS, PROJ. MGR.
  D. GREENE, ASSISTANT
- MAD RIVER DAM *
- SUCKER BROOK DAM *

THAMES RIVER BASIN
R.F. DOHERTY, BASIN REGULATOR

- MANSFIELD HOLLOW LAKE
  W. HAWTHORNE, PROJ. MGR.
  D. WARREN, ASSISTANT
- BUFFUMVILLE LAKE
  J.B. HAY, PROJ. MGR.
  R. FREYTAG, ASSISTANT
- HODGES VILLAGE DAM
  D.W. CLARK, PROJ. MGR.
  ASSISTANT
- EAST BRIMFIELD LAKE
  F. DION, PROJ. MGR.
  L.J. ROBERTS, ASSISTANT
- WESTVILLE LAKE
  W.T. SMITH, PROJ. MGR.
  R.J. TRYBA, ASSISTANT
- WEST THOMPSON LAKE
  C.A. BUSWELL, PROJ. MGR.
  ASSISTANT

BLACKSTONE RIVER BASIN
R.F. DOHERTY, BASIN REGULATOR

- WEST HILL DAM
  J.M. CLARKIN, PROJ. MGR.

MERRIMACK RIVER BASIN
R.W. MIRICK, BASIN REGULATOR

- FRANKLIN FALLS DAM
  R.D. MAYO, PROJ. MGR.
  O. LAROCHE, ASSIST.
  R. TETREAULT
- BLACKWATER DAM
  J. ROBERTS, PROJ. MGR.
- EDWARD MACDOWELL DAM
  J. RATHBURN, PROJ. MGR.
  K.B. WETHERBEE, ASSIST.
- HOPKINTON LAKE
  R.A. GOLEC, PROJ. MGR.
  E.P. MCCABE, ASSISTANT
- EVERETT LAKE
  J.A. PLIFKA, PROJ. MGR.
  W. TURNER, ASSISTANT

HURRICANE BARRIERS
J. FINEGAN, REGULATOR

- NEW BEDFORD BARRIER
  J.J. ARRUDA, PROJ. MGR.
  F.M. CALDWELL, ASSIST.
- STAMFORD BARRIER
  J. KATSURANIS, PROJ. MGR.
- FOX POINT BARRIER
  ADVISORIES TO PROVIDENCE R.I. PUBLIC WORKS DEPT.
- PAWCATUCK, CONN.
  ADVISORIES TO POLICE CHIEF.

* Maintained By State

RCC ASSISTANTS
T.D. BUCKELEW
P.E. HETU
J.L. HOROWITZ
G.A. LARAWAY

WCB ASSISTANTS
W.E. BRUDNICK
D.P. BUELOW
P.J. BURNS
R.A. CASSIDY
O.L. DONATI
T.M. FEENEY
K.M. MERLI
R.P. MICHIELUTTI
S.D. PARKER
F.H. SHARROCKS

RESERVOIR MANAGERS

B. MANOR	HOUSATONIC R. BASIN
S. ALEXANDER	THAMES R. BASIN
A. SAWICKI	MERRIMACK R. BASIN
H. LAWTON	CONN. R. BASIN (UPPER)
J. LEDGERE	CONN. R. BASIN (LOWER)

ORGANIZATION CHART FOR RESERVOIR REGULATION

DIVISION ENGINEER
ENGINEERING DIVISION
WATER CONTROL BRANCH
RESERVOIR CONTROL CENTER

ORGANIZATION CHART
RESERVOIR REGULATION

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

APRIL 1974

PLATE F-22

ELEVATION IN FEET ABOVE MEAN SEA LEVEL

MILES ABOVE MOUTH OF MILLERS RIVER
(APPLICABLE TO MILLERS RIVER ONLY)

LEGEND
EXISTING DAMS (NON-CORPS OF ENGINEERS)
EXISTING FLOOD CONTROL PROJECT

CONNECTICUT RIVER FLOOD CONTROL
MILLERS RIVER WATERSHED
PROFILES
MILLERS RIVER AND TRIBUTARIES
U.S. ARMY ENGINEER DIVISION NEW ENGLAND
CORPS OF ENGINEERS WALTHAM, MASS
JUNE 1972

PLATE F-23

ANNUAL PRECIPITATION
MILLERS RIVER WATERSHED
(Depth in Inches)

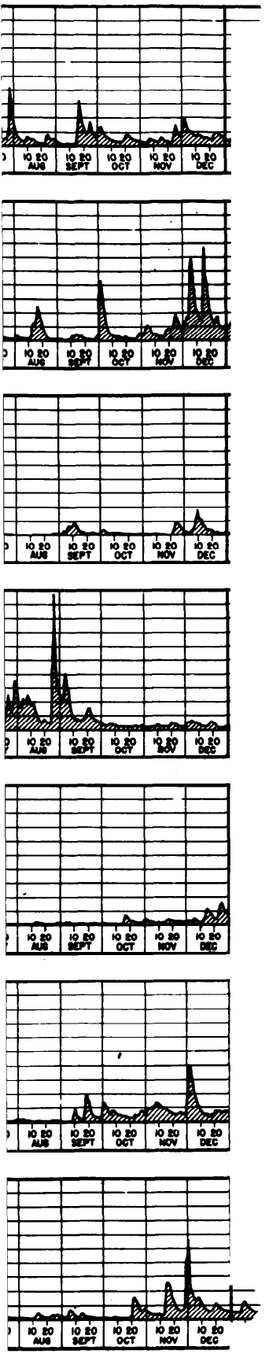
CALENDAR YEAR	WINCHENDON, MASS. (Elevation 1,020 ft msl) 77 Years of Record Through 1970	BIRCH HILL DAM ROYALSTON, MASS. (Elevation 840 ft msl) 22 Years of Record Through 1970	TULLY LAKE ROYALSTON, MASS. (Elevation 685 ft msl) 21 Years of Record Through 1970	TURNERS FALLS, MASS. (Elevation 190 ft msl) 71 Years of Record Through 1970
1890				-----
1891				-----
1892				-----
1893				37.64
1894	31.31			27.66(2)
1895	40.14			35.00
1896	37.27			37.04
1897	51.14			-----
1898	50.64			44.03
1899	39.06			-----
1900	48.44			-----
1901	45.97			-----
1902	46.05			-----
1903	43.13			37.45
1904	40.40			39.44
1905	41.88			36.54
1906	37.65			42.48
1907	41.11			44.14
1908	30.72			36.68
1909	38.71			44.10
1910	33.25			34.56
1911	38.30			42.79
1912	37.26			39.36
1913	37.01			33.28
1914	35.12			31.48
1915	44.02			49.54
1916	45.93			43.79
1917	43.14			38.71
1918	40.12			35.32
1919	44.83			38.58
1920	54.79			-----
1921	44.35			43.18
1922	52.15			39.26
1923	44.71			33.43
1924	35.20			28.95
1925	45.15			-----
1926	38.69			33.70
1927	48.94			42.53
1928	43.87			42.69
1929	38.85			36.07
1930	33.30			33.31
1931	39.99			38.62
1932	40.05			38.16
1933	48.37			42.37
1934	45.25			45.34
1935	38.03			35.04
1936	49.56			44.41
1937	49.95			49.91
1938	59.98(1)			55.18(1)
1939	32.08			36.57
1940	42.10			45.16
1941	29.08			29.17
1942	45.17			51.06
1943	41.28			40.70
1944	37.18			46.34
1945	43.46			53.25
1946	39.13			40.34
1947	35.31			43.42
1948	39.70			40.85
1949	34.24	32.33		35.75
1950	39.83	40.51	42.75	44.44
1951	50.69	49.60	54.28(1)	52.91
1952	39.09	36.88	39.93	44.25
1953	49.54	46.82	51.62	49.08
1954	48.20	41.68	45.54	47.10
1955	42.35	42.24	47.42	52.54
1956	39.67	36.23	37.44	41.74
1957	37.56	31.09	35.86	32.72
1958	39.96	35.21	39.62	37.29
1959	47.84	42.69	49.13	46.22
1960	55.69	50.49(1)	51.97	45.79
1961	44.50	36.63	36.10	34.48
1962	39.56	34.91	38.23	36.26
1963	34.34	28.78	32.51	31.23
1964	30.62	26.73	27.67(2)	30.75
1965	28.26(2)	25.91(2)	31.09	33.07
1966	36.20	29.43	32.94	35.20
1967	44.56	39.39	43.24	43.28
1968	38.79	38.79	40.53	42.92
1969	48.33	41.85	45.53	50.23
1970	42.09	37.27	39.07	36.62
MEAN	41.69	37.52	41.07	40.32

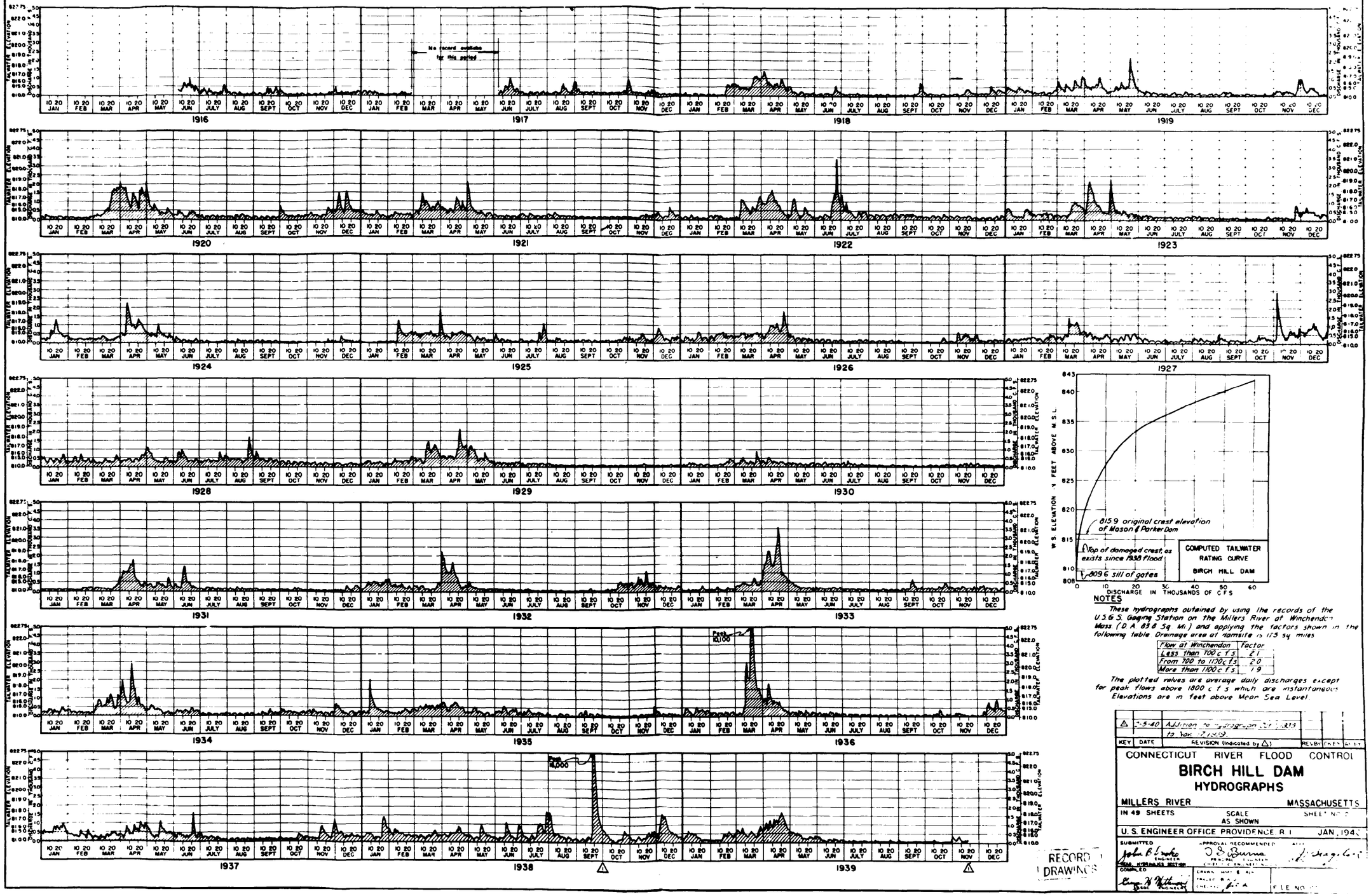
(1) Maximum annual precipitation for period of record.
(2) Minimum annual precipitation for period of record.

PLATE F-24

WAR DEPARTMENT

CORPS OF ENGINEERS U S ARMY





NOTES

These hydrographs outained by using the records of the U.S.G.S. Gaging Station on the Millers River at Winchendon Mass. (D.A. 438 Sq. Mi.) and applying the factors shown in the following table. Drainage area at damsite is 173 sq. miles

Flow at Winchendon	Factor
Less than 700 c.f.s.	2.1
From 700 to 1100 c.f.s.	2.0
More than 1100 c.f.s.	1.9

The plotted values are average daily discharges except for peak flows above 1800 c.f.s. which are instantaneous. Elevations are in feet above Mean Sea Level.

KEY	DATE	REVISION (Indicated by △)	REVBY	CHKD	APVD
△	7-5-40	Addition to hydrograph 1937, 1938 to Nov. 1, 1939			

CONNECTICUT RIVER FLOOD CONTROL

BIRCH HILL DAM
HYDROGRAPHS

MILLERS RIVER — MASSACHUSETTS

IN 49 SHEETS — SCALE AS SHOWN — SHEET NO.

U.S. ENGINEER OFFICE PROVIDENCE, R.I. — JAN. 1940

SUBMITTED — APPROVAL RECOMMENDED — APPROVED

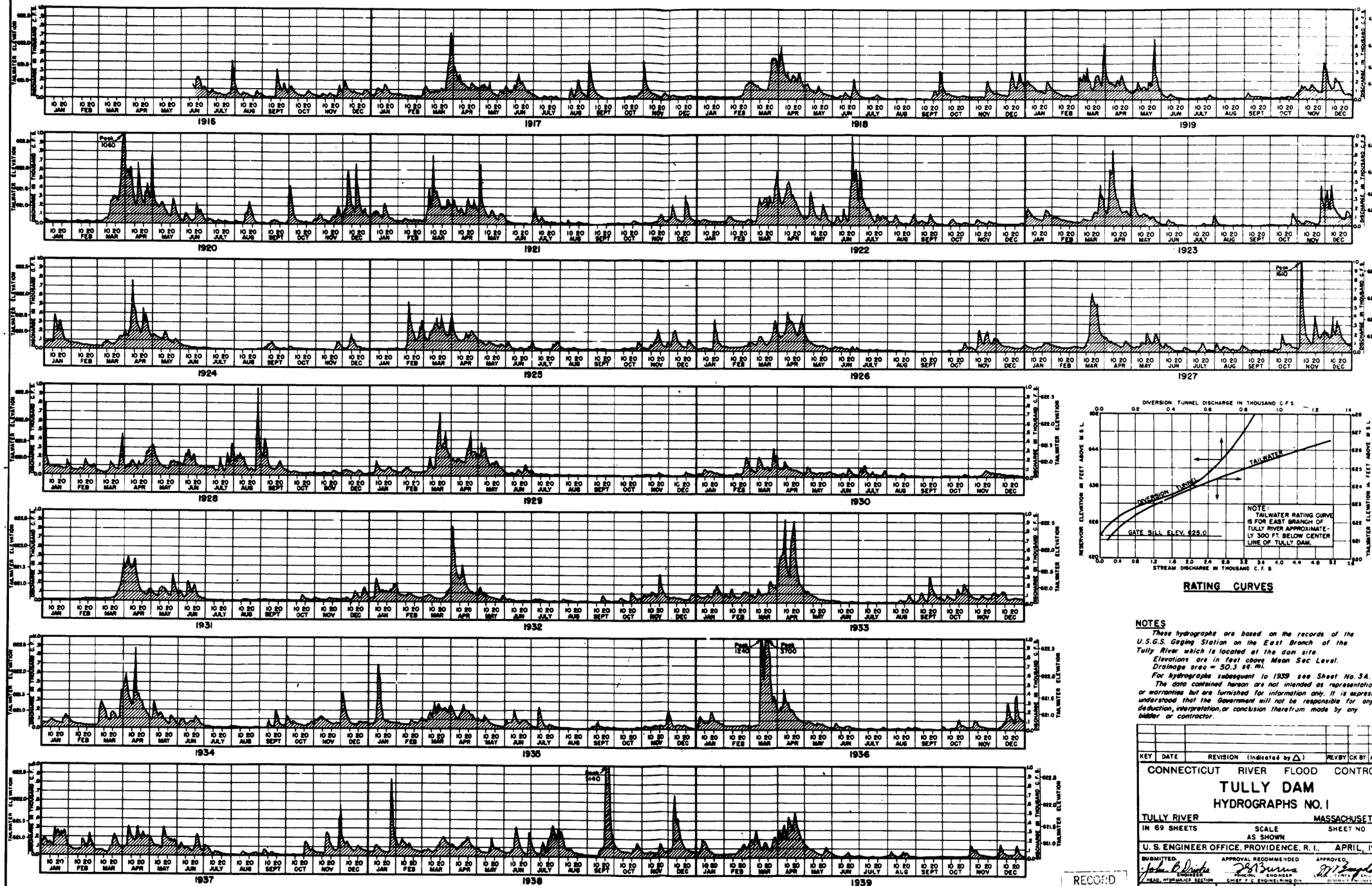
COMPILED — DRAWN — TRACED — CHECKED — FILE NO.

RECORD DRAWINGS

PLATE F-25

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY



RATING CURVES

NOTES

These hydrographs are based on the records of the U.S.G.S. Gaging Station on the East Branch of the Tully River which is located at the dam site.

Elevations are in feet above Mean Sea Level.

Drainage area = 50.3 sq. mi.

For hydrographs subsequent to 1939 see Sheet No. 34.

The data contained hereon are not intended as representations or warranties but are furnished for information only. It is expressly understood that the Government will not be responsible for any deduction, interpretation, or conclusion therefrom made by any bidder or contractor.

KEY	DATE	REVISION (Indicated by △)	REV BY	CK BY	AP BY

CONNECTICUT RIVER FLOOD CONTROL

TULLY DAM

HYDROGRAPHS NO. 1

TULLY RIVER — MASSACHUSETTS

IN 69 SHEETS — SCALE AS SHOWN — SHEET NO 3

U. S. ENGINEER OFFICE, PROVIDENCE, R. I. — APRIL, 1940

SUBMITTED: John B. Wisdom, ENGINEER, HEAD, HYDRAULICS SECTION

APPROVAL RECOMMENDED: J. B. Burns, PRINCIPAL ENGINEER, CHIEF, E.S. ENGINEERING DIV.

APPROVED: W. M. Bangley, Lt. Col., Corps of Engrs., DISTRICT ENGINEER

COMPILED: George H. Mitchell, ASSOC. ENGINEER

DRAWN M.A.S. & H.M.S.

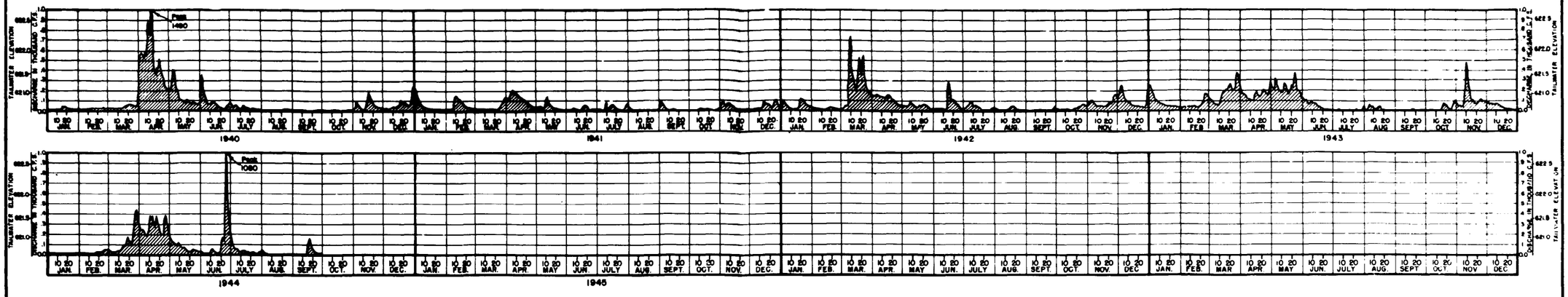
TRACED W.L.

CHECKED H.J.d

FILE NO. CT-S-109R

RECORD DRAWINGS

PLATE F-26



NOTES

These hydrographs are based on the records of the U.S.G.S. Gaging Station on the East Branch of the Tully River which is located at the dam site.

Elevations are in feet above Mean Sea Level.

Drainage area = 50.3 sq. mi.

For hydrographs prior to 1940, see Sheet No. 3

The data contained hereon are not intended as representations or warranties but are furnished for information only. It is expressly understood that the Government will not be responsible for any deduction, interpretation, or conclusion therefrom made by any bidder or contractor.

Years of record 1943 and 1944 added in April 1946.

KEY	DATE	REVISION (indicated by Δ)	DRAWN	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

TULLY DAM
HYDROGRAPHS NO. 2

TULLY RIVER — MASSACHUSETTS

IN 69 SHEETS — SCALE AS SHOWN — SHEET NO 3A

U.S. ENGINEER OFFICE, PROVIDENCE, R.I., C.C. 1944

SUBMITTED	APPROVAL RECOMMENDED	APPROVED
SENIOR ENGINEER, HEAD HYDRAULIC SECTION	HEAD ENGINEER, CHIEF ENGINEERING DIV.	COL. CORPS OF ENGINEERS, DISTRICT ENGINEER

PREPARED — HYDRAULIC SECTION — DRAWN A.B.M. — TRACED G.M.K. — CHECKED O.C.F. — FILE NO CT-3-1234

PLATE F-27

ANNUAL RUNOFF
MILLERS RIVER WATERSHED

WATER YEAR	PRIEST BROOK NEAR WINCHENDON, MASS. D.A. = 19.4 SQ. MI. 1916-1970		MILLERS RIVER AT SOUTH ROYALSTON, MASS.(1) D.A. = 187 SQ. MI. 1940-1970		EAST BRANCH TULLY RIVER NEAR ATHOL, MASS.(1) D.A. = 50.4 SQ. MI. 1916-1970		MILLERS RIVER AT ERVING, MASS.(1) D.A. = 375 SQ. MI. 1914-1970	
	CFS	INCHES	CFS	INCHES	CFS	INCHES	CFS	INCHES
1914	---	----	---	----	---	----	---	----
1915	---	----	---	----	---	----	471	17.29
1916	---	----	---	----	---	----	755	27.61
1917	36	25.81	---	----	91	24.69	646	23.57
1918	---	----	---	----	81	21.86	528	19.24
1919	37	26.95	---	----	90	24.33	595	21.71
1920	48	34.90	---	----	119	32.14	813	29.67
1921	39	28.18	---	----	101	27.45	782	28.54
1922	46	33.05	---	----	118	31.85	837	30.54
1923	29	21.19	---	----	73	19.76	606	22.14
1924	37	26.85	---	----	86	23.35	630	23.05
1925	22	16.06	---	----	65	17.58	438	15.99
1926	25	18.35	---	----	69	18.73	513	18.72
1927	28	20.53	---	----	75	20.20	511	18.66
1928	(3) 55	39.86	---	----	(3) 140	38.10	948	34.69
1929	33	23.85	---	----	79	21.37	657	23.96
1930	14	10.03	---	----	38	10.35	297	10.84
1931	23	16.38	---	----	53	14.24	417	15.21
1932	22	15.87	---	----	59	16.04	482	17.59
1933	35	25.37	---	----	92	24.89	716	26.07
1934	30	21.75	---	----	91	24.75	691	25.33
1935	32	23.27	---	----	88	23.87	671	24.58
1936	34	24.67	---	----	90	24.53	715	26.33
1937	34	24.29	---	----	91	24.87	711	26.09
1938	48	34.98	---	----	126	34.35	(3) 1,012	37.14
1939	35	24.69	---	----	87	23.79	(2) 665	24.19
1940	34	24.10	317	23.05	82	22.14	621	22.52
1941	17	11.84	188	13.65	46	12.30	491	17.76
1942	27	18.91	244	17.72	64	17.31	354	12.80
1943	33	23.02	330	23.94	84	22.67	650	23.54
1944	29	20.35	295	21.46	75	20.39	558	20.26
1945	41	28.42	396	28.76	102	27.45	765	27.70
1946	34	23.56	331	24.01	82	22.03	632	22.88
1947	28	19.72	274	19.90	70	18.87	548	19.86
1948	34	23.79	325	23.61	83	22.43	632	22.94
1949	21	14.74	244	17.67	57	15.32	447	16.17
1950	27	18.82	220	15.95	68	18.21	459	16.64
1951	44	30.47	370	26.88	100	26.97	753	27.27
1952	46	32.00	414	30.14	112	30.13	828	30.05
1953	38	26.81	377	27.39	89	24.00	745	26.99
1954	35	24.27	346	25.12	79	21.35	643	23.28
1955	35	24.38	336	24.38	81	21.89	664	24.04
1956	43	30.36	457	33.26	95	25.60	821	29.78
1957	22	15.59	223	16.20	51	13.70	429	15.50
1958	34	24.04	333	24.17	75	20.20	627	22.72
1959	28	19.35	257	18.65	58	15.68	480	17.38
1960	49	34.63	(3) 490	35.63	118	31.89	917	33.30
1961	30	20.76	347	25.15	75	20.12	621	22.47
1962	22	15.33	263	19.08	49	13.11	454	16.45
1963	23	15.99	251	18.21	58	15.54	448	16.22
1964	22	15.43	238	17.36	53	14.25	433	15.70
1965	(4) 8	5.73	(4) 102	7.39	(4) 23	6.18	(4) 196	7.08
1966	18	12.47	158	11.46	44	11.71	301	10.89
1967	31	21.50	310	22.51	75	20.27	595	21.57
1968	29	20.16	303	22.09	72	19.34	569	20.66
1969	37	25.62	328	23.82	83	22.44	621	22.47
1970	39	27.26	366	26.56	94	25.47	731	26.47
AVERAGE	32.1	22.76	304	22.10	80	21.52	610	22.18

(1) Runoff adjusted for change in contents in reservoir storage at Birch Hill Dam and/or Tully Lake.
(2) Gage relocated 2.5 miles downstream. Drainage area 375 sq. mi. (prior to 1 Jan 1939, 370 sq. mi.)
(3) Maximum annual runoff for period of record.
(4) Minimum annual runoff for period of record.

PLATE F-28

thin their means. While it is obvious that no regimen can produce all the

(Rev. 2-67) (

GEOLOGICAL SURVEY (WATER RESOURCES DIVISION)

Rating table for Connecticut River at Montague City, Mass.

from October 1, 1966 *to* , *from* *to* , *from*

Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge
Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs
17.00	30600	360	19.00	39000	380	21.00	46800	400	23.00	55000	440	25.00	64000	480	27.00	7380
.10	30960	360	.10	39380	380	.10	47200	400	.10	55440	440	.10	64480	480	.10	7432
.20	31320	360	.20	39760	380	.20	47600	400	.20	55880	440	.20	64960	480	.20	7484
.30	31680	360	.30	40140	380	.30	48000	400	.30	56320	440	.30	65440	480	.30	7536
.40	32040	360	.40	40520	380	.40	48400	400	.40	56760	440	.40	65920	480	.40	7588
.50	32400	360	.50	40900	380	.50	48800	400	.50	57200	440	.50	66400	480	.50	7640
.60	32760	360	.60	41280	380	.60	49200	400	.60	57640	440	.60	66880	480	.60	7692
.70	33120	360	.70	41660	380	.70	49600	400	.70	58080	440	.70	67360	480	.70	7744
.80	33480	360	.80	42040	380	.80	50000	400	.80	58520	440	.80	67840	480	.80	7796
.90	33840	360	.90	42420	380	.90	50400	400	.90	59660	440	.90	68320	480	.90	7848
18.00	35200	380	20.00	42800	400	22.00	50800	420	24.00	59400	460	26.00	68800	500	28.00	7900
.10	35580	380	.10	43200	400	.10	51220	420	.10	59860	460	.10	69300	500	.10	7952
.20	35960	380	.20	43600	400	.20	51640	420	.20	60320	460	.20	69800	500	.20	8004
.30	36340	380	.30	44000	400	.30	52060	420	.30	60780	460	.30	70300	500	.30	8056
.40	36720	380	.40	44400	400	.40	52480	420	.40	61240	460	.40	70800	500	.40	8108
.50	37100	380	.50	44800	400	.50	52900	420	.50	61700	460	.50	71300	500	.50	8160
.60	37480	380	.60	45200	400	.60	53320	420	.60	62160	460	.60	71800	500	.60	8212
.70	37860	380	.70	45600	400	.70	53740	420	.70	62620	460	.70	72300	500	.70	8264
.80	38240	380	.80	46000	400	.80	54160	420	.80	63080	460	.80	72800	500	.80	8316
.90	38620	380	.90	46400	400	.90	54580	420	.90	63540	460	.90	73300	500	.90	8368

This table is applicable for open-channel conditions. It is based on _____ discharge measurements made during _____

It is identical with rating 19 above and is _____ well defined between 5,000 cfs and 150,000 cfs.

6.0 feet

PLATE F-29

U.S

(REV. 2-67)

GEOLOGICAL SURVEY (WATER RESOURCES DIVISION)

Sta. No. 1 1 1 - (- 1 1

Rating table for Connecticut River at Montague City, Mass.

Table No. 2 0

from October 1, 1935 *to* ____, *from* ____ *to* ____, *from* ____ *to* ____

Begin 3 5 1 0 0 1 _ _
YR. MO. D. HR.

Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference
Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs
31.00	95000	550	33.00	106500	650	35.00	120000	700	37.00	134000	700	39.00	149000	800	41.00	165000	800	43.00	181000	800
.10	95550	550	.10	107150	650	.10	120700	700	.10	134700	700	.10	149800	800	.10	165800	800	.10	181800	800
.20	96100	550	.20	107800	650	.20	121400	700	.20	135400	700	.20	150600	800	.20	166600	800	.20	182600	800
.30	96650	550	.30	108450	650	.30	122100	700	.30	136100	700	.30	151400	800	.30	167400	800	.30	183400	800
.40	97200	550	.40	109100	650	.40	122800	700	.40	136800	700	.40	152200	800	.40	168200	800	.40	184200	800
.50	97750	550	.50	109750	650	.50	123500	700	.50	137500	700	.50	153000	800	.50	169000	800	.50	185000	800
.60	98300	550	.60	110400	650	.60	124200	700	.60	138200	700	.60	153800	800	.60	169800	800	.60	185800	800
.70	98850	550	.70	111050	650	.70	124900	700	.70	138900	700	.70	154600	800	.70	170600	800	.70	186600	800
.80	99400	550	.80	111700	650	.80	125600	700	.80	139600	700	.80	155400	800	.80	171400	800	.80	187400	800
.90	99950	550	.90	112350	650	.90	126300	700	.90	140300	700	.90	156200	800	.90	172200	800	.90	188200	800
32.00	100500	600	34.00	113000	700	36.00	127000	700	38.00	141000	800	40.00	157000	800	42.00	173000	800	44.00	189000	800
.10	101100	600	.10	113700	700	.10	127700	700	.10	141800	800	.10	157800	800	.10	173800	800	.10	189800	800
.20	101700	600	.20	114400	700	.20	128400	700	.20	142600	800	.20	158600	800	.20	174600	800	.20	190600	800
.30	102300	600	.30	115100	700	.30	129100	700	.30	143400	800	.30	159400	800	.30	175400	800	.30	191400	800
.40	102900	600	.40	11580	700	.40	129800	700	.40	144200	800	.40	160200	800	.40	176200	800	.40	192200	800
.50	103500	600	.50	116500	700	.50	130500	700	.50	145000	800	.50	161000	800	.50	177000	800	.50	193000	800
.60	104100	600	.60	117200	700	.60	131200	700	.60	145800	800	.60	161800	800	.60	177800	800	.60	193800	800
.70	104700	600	.70	117900	700	.70	131900	700	.70	146600	800	.70	162600	800	.70	178600	800	.70	194600	800
.80	105300	600	.80	118600	700	.80	132600	700	.80	147400	800	.80	163400	800	.80	179400	800	.80	195400	800
.90	105900	600	.90	119300	700	.90	133300	700	.90	148200	800	.90	164200	800	.90	180200	800	.90	196200	800

This table is applicable for open-channel conditions. It is based on ____ discharge measurements made during ____

It is identical with rating 19 above and is ____ well defined between 5,000 cfs and 150,000 cfs.

6.0 feet.

Comp. by RAG date 12-8-70

Ckd. by JWB date 12-17-70

PLATE F-30

U.S. GOVERNMENT PRINTING OFFICE : 1967 OF—249-765

GEOLOGICAL SURVEY (WATER RESOURCES DIVISION)

Table No. 4 6

Rating table for Millers River at Erving, Mass.

Begin 7 1 1 0 0 1 (YR. MO. D. HR.)

from Oct 1, 1971 *to* ..... , *from* ..... *to* ..... , *from* ..... *to* .....

Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference
Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs
.00			2.00	107	23	4.00	1230	95	6.00	3750	170	.00			.00			.00		
.10			.10	130	25	.10	1325	95	.10	3920		.10			.10			.10		
.20			.20	155	30	.20	1420	100	.20	4090	170	.20			.20			.20		
.30			.30	185	30	.30	1520		.30	4260	180	.30			.30			.30		
.40			.40	215	35	.40	1620		.40	4440		.40			.40			.40		
.50			.50	250	40	.50	1720	100	.50	4620	180	.50			.50			.50		
.60			.60	290	40	.60	1820	110	.60	4800		.60			.60			.60		
.70			.70	330	45	.70	1930		.70			.70			.70			.70		
.80			.80	375	50	.80	2040	120	.80			.80			.80			.80		
.90			.90	425	55	.90	2160	120	.90			.90			.90			.90		
1.00			3.00	480	60	5.00	2280	130	7.00			.00			.00			.00		
.10			.10	540	65	.10	2410	130	.10			.10			.10			.10		
.20			.20	605	65	.20	2540	140	.20			.20			.20			.20		
.30			.30	670	70	.30	2680	140	.30			.30			.30			.30		
.40	29	6.5	.40	740	75	.40	2820	150	.40			.40			.40			.40		
.50	35.5	8.5	.50	815	75	.50	2970		.50			.50			.50			.50		
.60	44	11	.60	890	80	.60	3120	150	.60			.60			.60			.60		
.70	55	14	.70	970	85	.70	3270	160	.70			.70			.70			.70		
.80	69	16.5	.80	1055	85	.80	3430		.80			.80			.80			.80		
.90	85.5	21.5	.90	1140	90	.90	3590	160	.90			.90			.90			.90		

This table is applicable for open-channel conditions. It is based on 9 discharge measurements made during 1963(248), 1967(287), 1969(298), 1970(308), 1972(313-316), 1973(317) and is well defined [redacted].

It is identical with rating 45 below 4.8 ft.

Comp. by RAG date 12-20-72

Ckd. by ABD date 1-5-72

PLATE F-31

U.S. GOVERNMENT PRINTING OFFICE : 1967 O—249-785

GEOLOGICAL SURVEY (WATER RESOURCES DIVISION)

Sta. No. 01-[illegible]-0000

Table No. 20

Rating table for Millers River at South Royalston, Mass.

Begin 72 03 18 (YR. MO. D. HR.)

from May 18, 1972 *to* ..., *from* ... *to* ..., *from* ... *to* ...

Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference
Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs
.00			4.00	65	15	6.00	930	80	.00			.00			.00			.00		
.10			.10	80	18	.10	1010		.10			.10			.10			.10		
.20			.20	98	21	.20	1090	80	.20			.20			.20			.20		
.30			.30	119	24	.30	1170	90	.30			.30			.30			.30		
.40			.40	143	27	.40	1260		.40			.40			.40			.40		
.50			.50	170	30	.50	1350	90	.50			.50			.50			.50		
.60			.60	200	33	.60	1440	100	.60			.60			.60			.60		
.70			.70	233	36	.70	1540	100	.70			.70			.70			.70		
.80			.80	269	38	.80	1640	110	.80			.80			.80			.80		
.90			.90	307	40	.90	1750	110	.90			.90			.90			.90		
3.00			5.00	347	42	7.00	1860	120	.00			.00			.00			.00		
.10			.10	389	46	.10	1980	120	.10			.10			.10			.10		
.20			.20	435	50	.20	2100	130	.20			.20			.20			.20		
.30			.30	485	55	.30	2230	130	.30			.30			.30			.30		
.40			.40	540	55	.40	2360	140	.40			.40			.40			.40		
.50	21	6	.50	595	60	.50	2500	140	.50			.50			.50			.50		
.60	27	7	.60	655	65	.60	2640		.60			.60			.60			.60		
.70	34	9	.70	720	65	.70			.70			.70			.70			.70		
.80	43	10	.80	785	70	.80			.80			.80			.80			.80		
.90	53	12	.90	855	75	.90			.90			.90			.90			.90		

This table is applicable for open-channel conditions. It is based on 6 discharge measurements made during 1971(307), 1972(312-315), 1973(316) and is [redacted] well defined.

It is identical with rating 19 below 4.0 ft. and above 5.6 ft. and with rating 17 at 5.6 ft.

Comp. by RAG date 12-18-72

Ckd. by ABD date 1-9-73

PLATE F-32

U.S. GOVERNMENT PRINTING OFFICE : 1967 O—249-765

GEOLOGICAL SURVEY (WATER RESOURCES DIVISION)

Table No. 4 4

Rating table for East Branch Tully River near Athol, Mass.

Begin 7 1 1 0 0 1 (YR. MO. D. HR.)

from Oct 1, 1971 *to* ..... , *from* ..... *to* ..... , *from* ..... *to* .....

Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference
Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs
.00			2.00			4.00	305	40	.00			.00			.00			.00		
.10			.10			.10	345	42	.10			.10			.10			.10		
.20			.20			.20	387	43	.20			.20			.20			.20		
.30			.25	0.01		.30	430	45	.30			.30			.30			.30		
.40			.30	.18		.40	475	50	.40			.40			.40			.40		
.50			.40	1.02		.50	525	50	.50			.50			.50			.50		
.60			.50	3.2		.60	575	55	.60			.60			.60			.60		
.70			.60	6.8		.70	630	60	.70			.70			.70			.70		
.80			.70	12.2		.80	690	60	.80			.80			.80			.80		
.90			.80	20	9.5	.90	750		.90			.90			.90			.90		
.00			.90	29.5	11.5	5.00			.00			.00			.00			.00		
.10			3.00	41	14	.10			.10			.10			.10			.10		
.20			.10	55	16	.20			.20			.20			.20			.20		
.30			.20	71	18	.30			.30			.30			.30			.30		
.40			.30	89	21	.40			.40			.40			.40			.40		
.50			.40	110	25	.50			.50			.50			.50			.50		
.60			.50	135	29	.60			.60			.60			.60			.60		
.70			.60	164	32	.70			.70			.70			.70			.70		
.80			.70	196	34	.80			.80			.80			.80			.80		
.90			.80	230	37	.90			.90			.90			.90			.90		
			.90	267	38															

This table is applicable for open-channel conditions. It is based on 14 discharge measurements made during 1971(513-516),1972(520-522,524-527),1973(528,529)

is identical with rating 43 below 3.4 ft. well defined. [redacted]

Comp. by JDC date 3-5-73

Ckd. by RAG date 4-11-73

PLATE F-33

U.S. GOVERNMENT PRINTING OFFICE : 1967 OF—249-765

AREA IN 100 ACRES

CREST ELEVATION 852 FT. M.S.L. = 37 FT. STAGE

6200 ACRES

AREA

CAPACITY

1" 2" 3" 4" 5"

4990 C.F.S. 5.3" R.O.

1" RUNOFF

DRAINAGE AREA = 175 SQ. MI.
ONE INCH RUNOFF = 9325 A.F.

INVERT ELEVATION = 815 FT. M.S.L. = 0' STAGE

POOL STAGE IN FEET

CAPACITY IN 1000 ACRE FEET

ELEVATION IN FEET M.S.L.

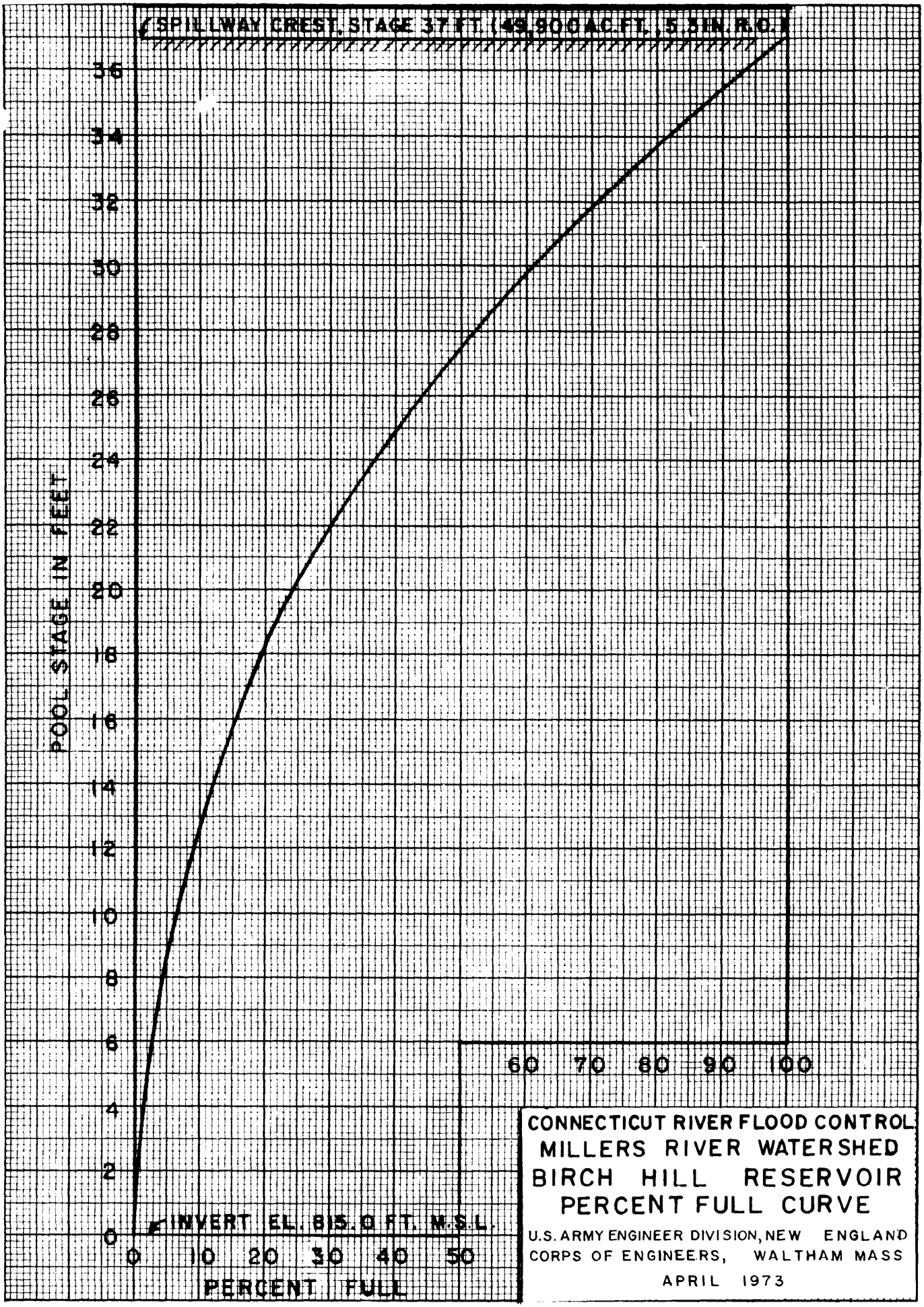
CONNECTICUT RIVER FLOOD CONTROL

BIRCH HILL DAM

AREA & CAPACITY CURVES

NEW ENGLAND DIVISION WALTHAM, MASS
NOVEMBER 1973

PLATE F-35



CONNECTICUT RIVER FLOOD CONTROL
MILLERS RIVER WATERSHED
BIRCH HILL RESERVOIR
PERCENT FULL CURVE

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS, WALTHAM MASS
APRIL 1973

PLATE F-36

TULLY RESERVOIR
AREA AND CAPACITY

DRAINAGE AREA = 50 SQ. MI.

ELEV. MSL	STAGE FEET	AREA ACRES	CAPACITY AC. FT.	CAPACITY INCHES
625	0	0	0	0
626	1	5	5	0
627	2	10	10	0
628	3	17	15	.01
629	4	20	20	.01
630	5	23	25	.01
631	6	32	125	.05
632	7	38	200	.08
633	8	45	225	.08
634	9	55	375	.14
635	10	65	425	.16
	Permanent Pool = 636			
636	11	78	525	.20
637	12	95	650	.24
638	13	112	825	.31
639	14	140	1,025	.39
640	15	210	1,225	.46
641	16	305	1,500	.60
	Recreation Pool = 641			
641	16	305	0	0
642	17	365	325	.12
643	18	420	700	.26
644	19	465	1,100	.41
645	20	505	1,525	.57
646	21	545	1,975	.74
647	22	580	2,525	.95
648	23	615	3,075	1.16
649	24	650	3,625	1.36
650	25	685	4,225	1.59
651	26	710	4,875	1.83
652	27	745	5,550	2.09
653	28	775	6,325	2.38
654	29	800	7,125	2.68
655	30	825	7,950	2.99
656	31	855	8,775	3.30
657	32	880	9,600	3.61
658	33	905	10,450	3.93
659	34	930	11,300	4.25
660	35	955	12,250	4.61
661	36	980	13,225	4.97
662	37	1,005	14,150	5.32
663	38	1,025	15,225	5.78
664	39	1,050	16,225	6.10
665	40	1,075	17,250	6.49
666	41	1,095	18,425	6.93
667	42	1,115	19,525	7.34
668	43	1,140	20,525	7.72
	Crest Elevation = 668			
669	44	1,160	21,525	8.09
670	45	1,185	22,525	8.47
671	46	1,205	23,525	8.85
672	47	1,225	24,525	9.22
673	48	1,245	25,525	9.60

AREA OF RESERVOIR IN 100 ACRES

1140 ACRES

CREST ELEVATION 668 FT M.S.L. = 43' STAGE

AREA

CAPACITY

1"

2"

3"

4"

5"

6"

7"

20,525 A.F.
7.7" R.O.

DRAINAGE AREA = 50 SQ MI.
ONE INCH RUNOFF = 2650 A.F

RECREATION POOL = 641 FT. M.S.L. = 16' STAGE

1600 A.F.
0.60" R.O.

PERMANENT POOL = 636 FT. M.S.L. = 11' STAGE

ESTIMATED

INVERT ELEVATION = 625 FT. M.S.L. = 0' STAGE

POOL STAGE IN FEET

ELEVATION IN FEET M.S.L.

CAPACITY IN 1000 ACRE FEET

CONNECTICUT RIVER FLOOD CONTROL

TULLY LAKE

AREA & CAPACITY CURVES

NEW ENGLAND DIVISION WALTHAM, MASS
NOVEMBER 1973

PLATE F-38

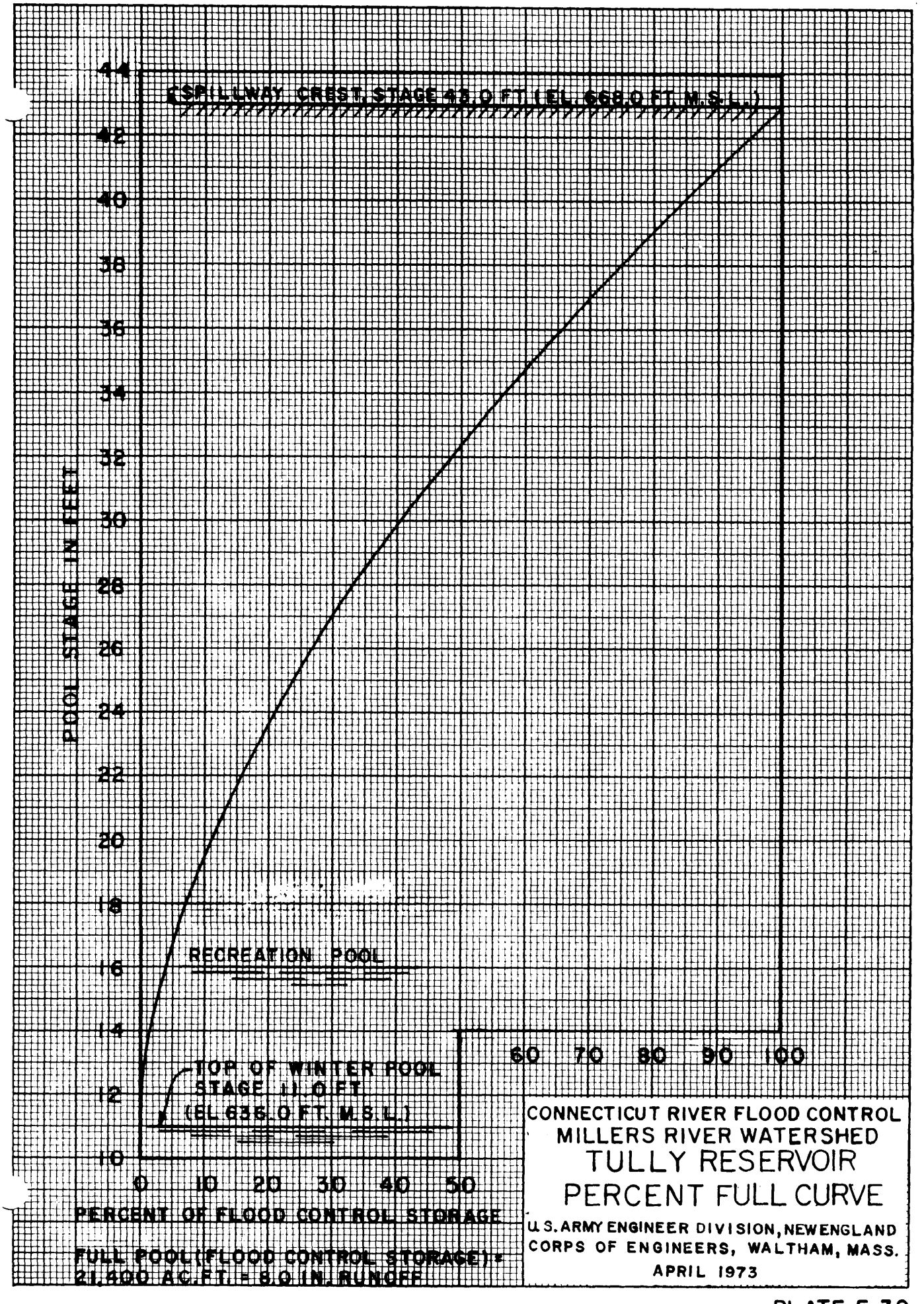
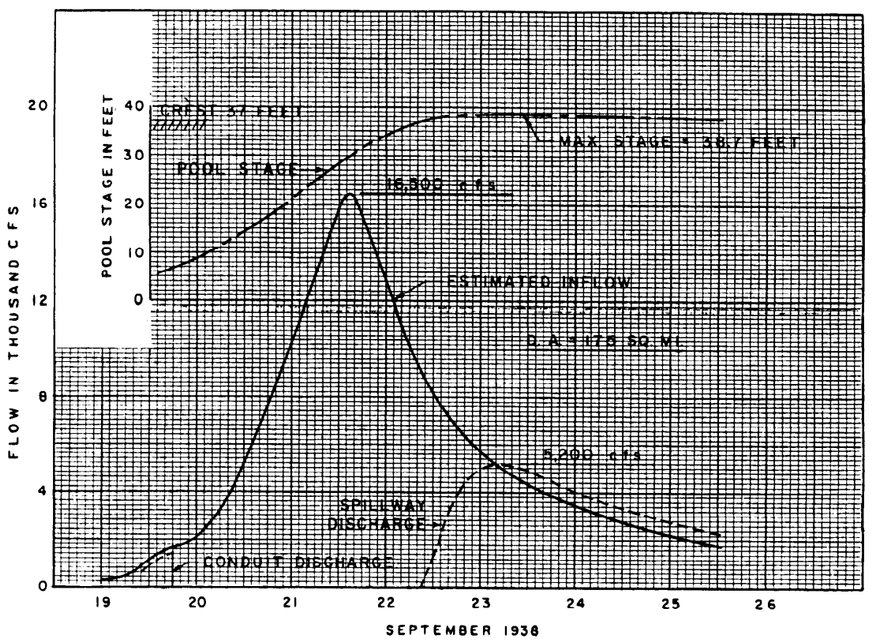
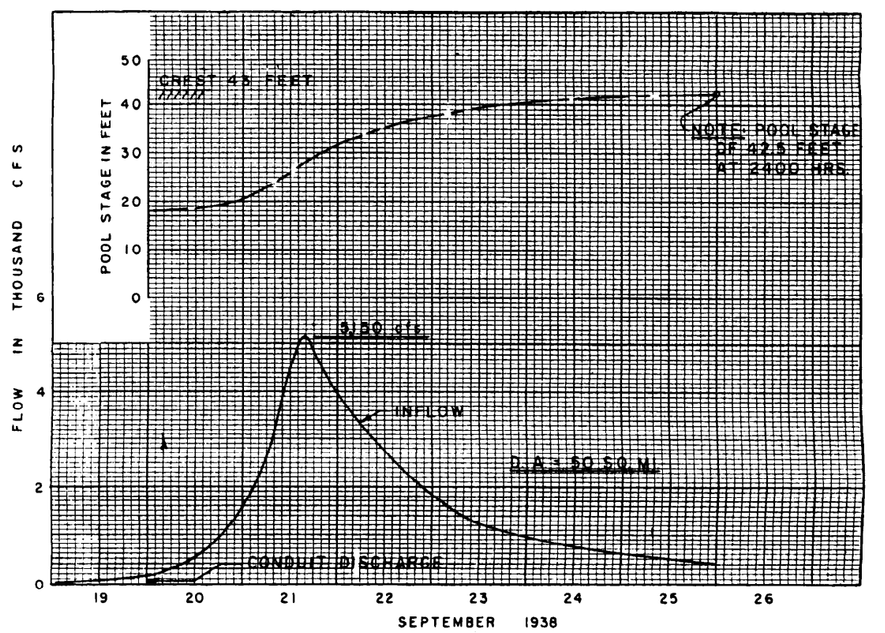

SPILLWAY CREST, STAGE 43.0 FT. (EL. 668.0 FT. M.S.L.)
RECREATION POOL
TOP OF WINTER POOL
STAGE 13.0 FT.
(EL 638.0 FT. M.S.L.)
POOL STAGE IN FEET
PERCENT OF FLOOD CONTROL STORAGE
FULL POOL (FLOOD CONTROL STORAGE) =
21,400 AC. FT. = 8.0 IN. RUNOFF
CONNECTICUT RIVER FLOOD CONTROL
MILLERS RIVER WATERSHED
TULLY RESERVOIR
PERCENT FULL CURVE
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS, WALTHAM, MASS.
APRIL 1973

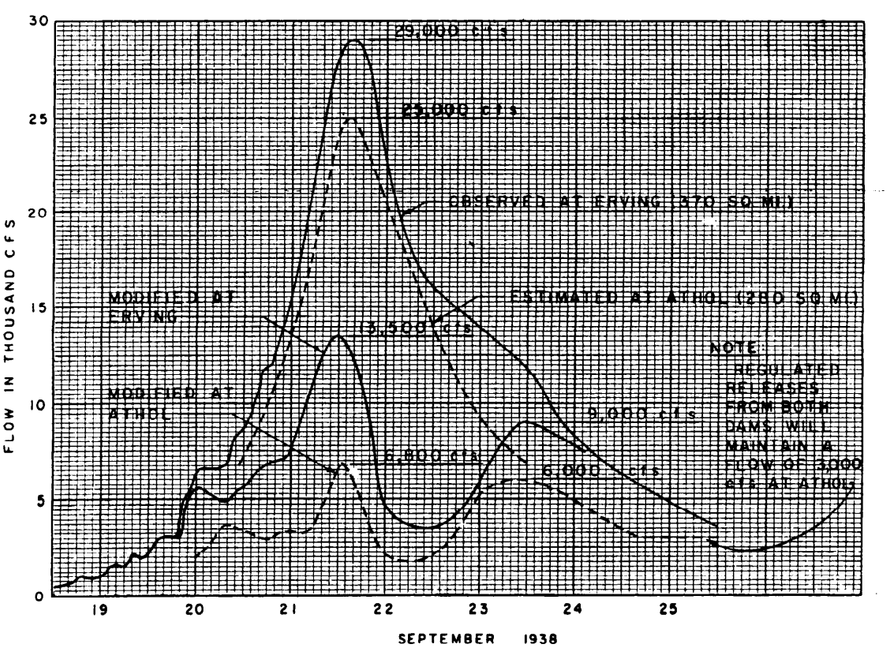
PLATE F-39



MILLERS RIVER AT BIRCH HILL RESERVOIR



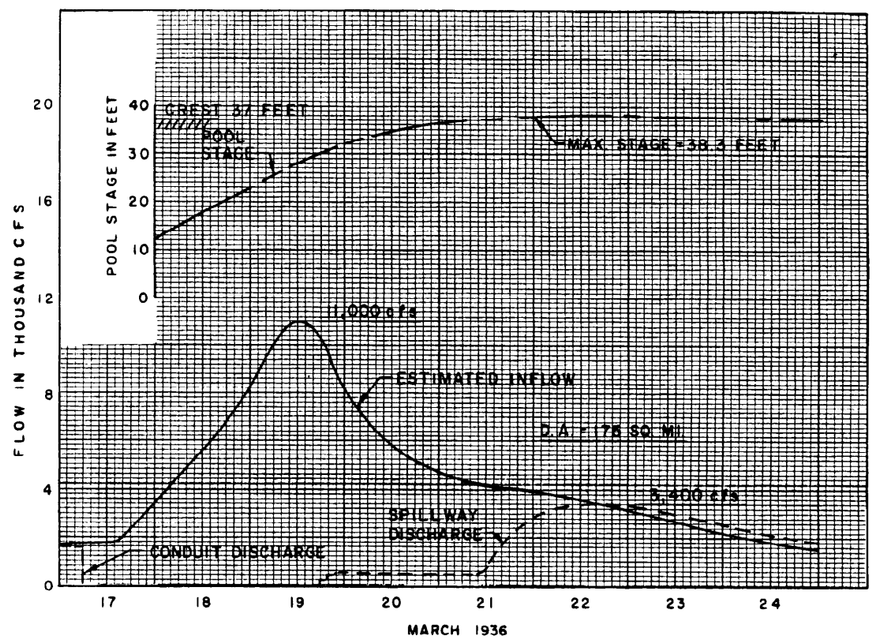
EAST BRANCH TULLY RIVER AT TULLY RESERVOIR



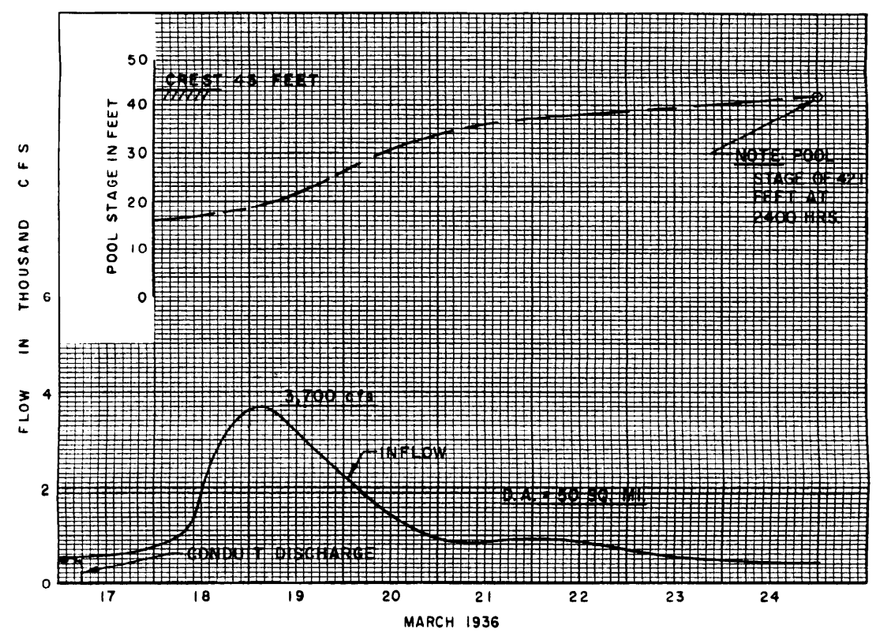
MILLERS RIVER AT ATHOL AND ERVING

CONNECTICUT RIVER FLOOD CONTROL
MILLERS RIVER BASIN
EFFECT OF BIRCH HILL AND TULLY RESERVOIRS ON FLOOD OF SEPTEMBER 1938
NEW ENGLAND DIVISION, WALTHAM, MASS.
JUNE 1973

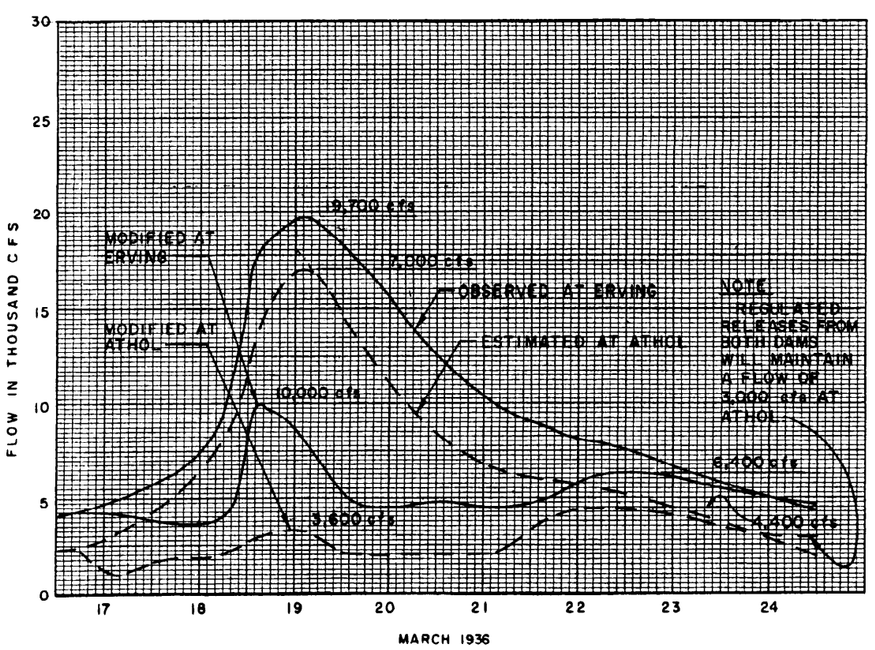
PLATE F-41



MILLERS RIVER AT BIRCH HILL RESERVOIR



EAST BRANCH TULLY RIVER AT TULLY RESERVOIR



MILLERS RIVER AT ATHOL AND ERVING

CONNECTICUT RIVER FLOOD CONTROL
MILLERS RIVER BASIN
EFFECT OF BIRCH HILL AND TULLY RESERVOIRS
ON
FLOOD OF MARCH 1936
NEW ENGLAND DIVISION, WALTHAM, MASS.
DECEMBER 1973

PLATE F-40

LOG OF RADIO REPORTS - FLOOD CONTROL DAMS

21 November 1973

WACHUSETT RELAY

Line	ITEM	264 WEST HILL	593 LITTLE-VILLE	25 KNIGHT-VILLE	24 BIRCH HILL	512 TULLY	38 BARRE FALLS	27 MANS-FIELD HOLLOW	43 WEST-VILLE	37 EAST BRIM-FIELD	592 WEST THOMP-SON	511 HODGES VILLAGE	36 BUFFUM-VILLE	BUZZARDS BAY 46 NEW BEDFORD BARRIER	Line
1	Time of Observation	0800	0800	0800	0800	0800	0800	0800	0800	0800	0800	0800	0800		1
2	Precipitation(last 24 hrs)	0	0	0	0	0	0	0	0	0	0	0	0		2
3	Form of Precipitation	-	-	-	-	-	-	-	-	-	-	-	-		3
4	Present Weather	Clear	P Cldy	P Cldy	Clear	Clear	Clear	Fog	P Cldy	Clear	P Cldy	Clear	P Cldy		4
5	Pool Stage	2.23	518.47	1.5	1.89	10.70	771.86	8.4	10.40	13.16	13.59	2.96	11.09		5
6	Tendency	F	S	S	F	S	F	RS	S	F	S	F	S		6
7	Gate Openings	3-0-3	2-2	3-3-3	4-0-0-4	25-0	3-3	1-F-0-1.2-0	0-F-0	2-2	0-F-0	3-3	0-F-0		7
8	Tailwater Gage	1.40	1.47	2.60	4.18	2.79	2.58	1.74	3.31	2.49	2.30	0.97	-		8
9	Outflow	11	21	117	91	18	18	94	30	18	63	11	17		9
	INDEX POINTS														
10		3.3										4.68			10
11		1.82	3.3/198									50			11
12															12
13															13
14															14
15															15
	REMARKS														
					BROKEN										
					STEMS										
					GATES										
					2 AND 3										

NED FORM MAR 77 477(A)

PLATE F-42

NED FORM APR 65 503

REGULATION OF RESERVOIRS AND LOG OF REPORTS AND INSTRUCTIONS

RCS NEDED-3

DATE AND TIME OF REPORT 1973	BIRCH HILL RES											TULLY RES.							PRECIPITATION			MILLERS RIVER AT MAIN STREET			CONNECTICUT RIVER AT MONTAGUE CITY			RIVER AT					
	RES POOL		GATE OPENING								OUTFLOW		RES POOL		GATE OPENING			OUTFLOW														
	HOUR	STAGE	1	2	3	4	5	6	7	8	T.W.	C.F.S	HOUR	STAGE	1	2	3	T.W.	C.F.S.	LOCATION	HOUR	INCHES INC	INCHES ACC	HOUR	STAGE	C.F.S	HOUR	STAGE	C.F.S	HOUR	STAGE	C.F.S	HOUR	STAGE	C.F.S
5 JUL	0800	13.80	5	0	0	5					6.27	1146	0800	17.98	0	3	0	3.68	175	Birch Hill		.53		0800	0.0		0800	24.8	63080						
																				Tully		.63												
	1100	13.67	5	0	0	5					6.26	1138	1100	17.94	0	3	0	3.68	175	Birch Hill		.05	.58	1100	0.0		1100	25.3	65440						
																				Tully		.05	.68											
	1500	13.51	5	0	0	5					6.26	1138	1500	17.87	0	3	0	3.68	175	Birch Hill		.07	.60	1500	.05		1500	26.0	68800						
		Go to	6	0	0	6														Tully		.09	.72											
6 JUL	0800	12.54	6	0	0	6					6.35	1215	0800	17.56	0	3	0	3.68	175					0800	.20		0800	23.5	57200						
		Go to	7	0	0	6																												
	GATES NO. 2 AND 3 INOPERABLE DUE TO BROKEN STEMS.																																	

PLATE F-43

NED FORM 102
15 Nov. 1951

RESERVOIR REGULATION
COMPUTATION OF INFLOW

Flood of April 1960

Reservoir Tully By _____ Date 4/11/60

TIME April 1960	RES. STAGE Feet	CHANGE IN RES. STAGE Feet per hour		FLOW into/from STORAGE c.f.s.	OUTFLOW c.f.s.	TOTAL INFLOW (5) + (6) c.f.s.	REMARKS
		Observed	Adjusted				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1/0000	9.8				380		
		1.5	.25	200		578	
0600	11.3				375		
		1.5	.25	300		687	
1200	12.8				400		
		1.4	.23	420		720	
1800	14.2				200		
		1.4	.23	600		800	
2/0000	15.6				200		
		1.2	.20	740		940	
0600	16.8				200		
		1.1	.18	800		1005	
1200	17.9				210		
		0.8	.13	660		875	
1800	18.7				220		
		0.7	.12	660		882	
3/0000	19.4				225		
		0.5	.08	460		687	
0600	19.9				230		
		0.1	.02	120		350	
1200	20.0				230		
		0.1	.02	120		350	
1800	20.1				230		
		0.5	.08	490		820	
4/0000	20.6				230		

PLATE F-44

Spillway Crest Elev = 852.0 M.S.L.

RESERVOIR STAGE - FEET

POOL ELEVATION FEET ABOVE M.S.L.

(Change in Reservoir stage in feet per hour)

0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.70
0.80
0.90
1.0

Conduit Invert Elev = 815.0 M.S.L.

FLOW INTO, OR FROM, STORAGE IN 1000 C.F.S.

BIRCH HILL RESERVOIR
CURVES FOR DETERMINATION OF RESERVOIR INFLOWS

New England Division
Boston, Mass. July, 1951

PLATE F-45

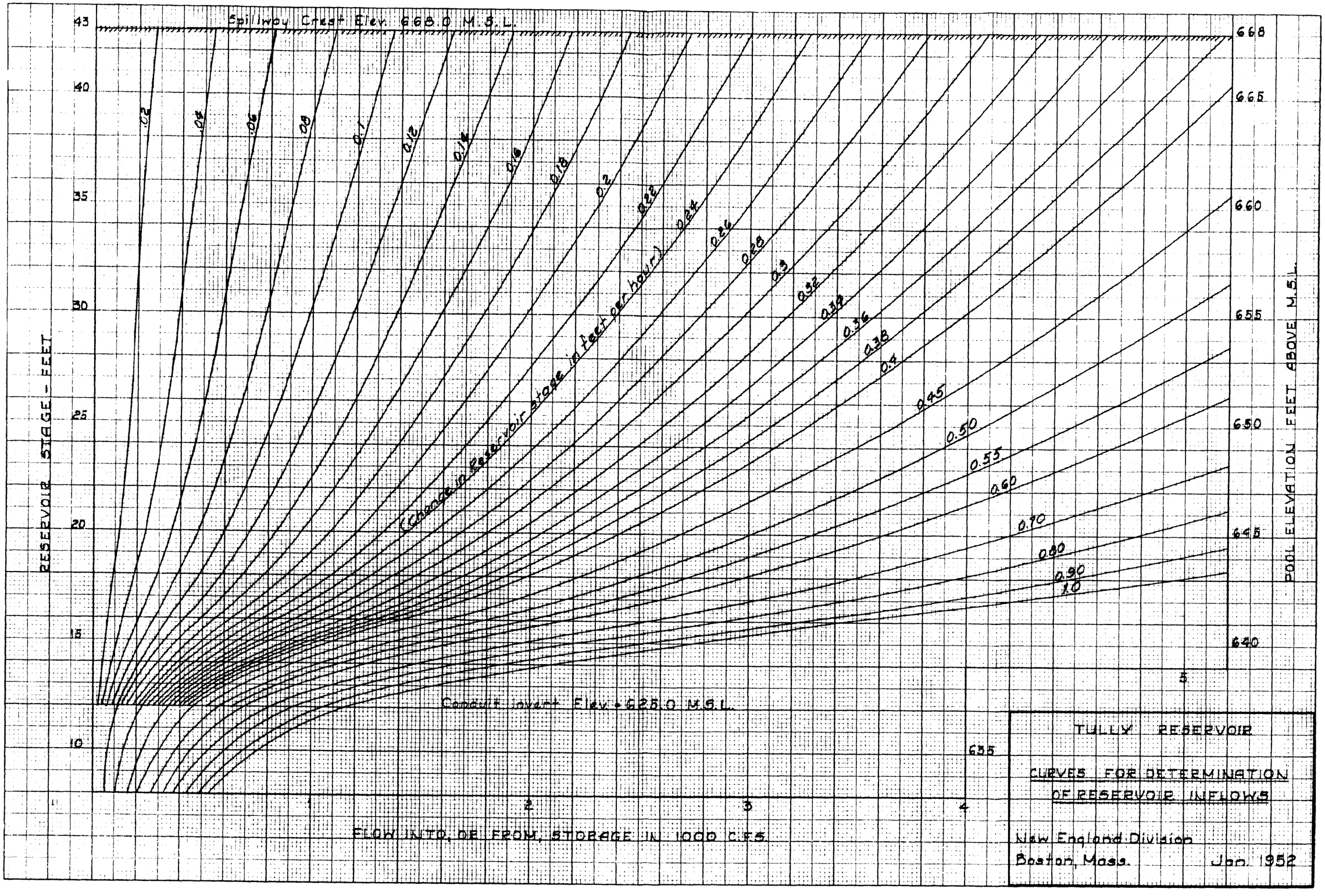

Spillway Crest Elev. 668.0 M.S.L.
RESERVOIR STAGE - FEET
POOL ELEVATION FEET ABOVE M.S.L.
43
40
35
30
25
20
15
10
668
665
660
655
650
645
640
.02
.04
.06
.08
0.1
0.12
0.14
0.16
0.18
0.2
0.22
0.24
0.26
0.28
0.3
0.32
0.34
0.36
0.38
0.4
0.45
0.50
0.55
0.60
0.70
0.80
0.90
1.0
(Change in reservoir stage in feet per hour)
Conduit invert Elev. 625.0 M.S.L.
635
1
2
3
4
5
FLOW INTO, OR FROM, STORAGE IN 1000 C.F.S.
TULLY RESERVOIR
CURVES FOR DETERMINATION OF RESERVOIR INFLOWS
New England Division
Boston, Mass.
Jan. 1952

PLATE F-46

GATE OPERATION RECORD

BIRCH HILL DAM RESERVOIR July MONTH 1973 YEAR

OPERATOR

LD.	DAY	HOUR	RES. STAGE	OUTFLOW	PRECIP.	T. W.	GATE SETTING 2 3 4 5 6 7 8	REMARKS
4 8	16	0800	2.89	165	.15	452	4004	Rain
	17	0800	2.72	150	.	446		
	18	0800	2.55	133	.	439		
	19	0800	2.39	115	.	431		
4 8	20	0800	2.26	104	.	425	4004	
	21	0800	2.52	138	.92	441		Rain
	22	0800	3.84	279	.08	488		Rain
	23	0800	3.87	276	.	487		
4 8	24	0800	3.77	257	.	482	4004	
	25	0800	3.54	233	.	475		
	26	0800	3.28	205	.	466		
	27	0800	3.13	190	.15	461		Rain
4 8	28	0800	3.25	204	.10	466	4004	Rain
	29	0800	2.93	171	.	454		
	30	0800	2.55	131	.	438		
	31	0800	2.28	105	.	426		

NED FORM SEP 70 90 REPLACES EDITION OF MAR 62 WHICH IS OBSOLETE

PLATE F-47

STANDARD OPERATING PROCEDURE (SOP)
FLOOD CONTROL REGULATION
BIRCH HILL DAM AND TULLY LAKE

PHASE	STORM RAINFALL (WITHIN 24-HR. PERIOD) ANTECEDENT CONDITIONS: SNOW-COV'RD WET OR FROZEN GROUND	STORM RAINFALL (WITHIN 24-HR. PERIOD) ANTECEDENT CONDITIONS: DRY GROUND	BIRCH HILL DAM POOL STAGE FEET	TULLY LAKE POOL STAGE FEET	RIVER INDEX STATIONS (STAGE IN FEET) MILLERS RIVER AT ATHOL (MAIN ST. BRIDGE) (280 SQ. MI.)	MILLERS RIVER AT ORANGE (MAIN ST. BRIDGE) (316 SQ. MI.)	MILLERS RIVER AT ERVING (375 SQ. MI.)	CONNECTICUT RIVER AT MONTAGUE CITY (7,865 SQ. MI.)	CONNECTICUT RIVER AT SPRINGFIELD	REGULATION INSTRUCTIONS GATE SETTINGS: BIRCH HILL DAM	REGULATION INSTRUCTIONS GATE SETTINGS: TULLY LAKE	DUTIES DURING EACH PHASE
I - APPRAISAL												
FIRST ALERT	1.0"	1.0"	SUMMER 6 (RISING)	SUMMER 19 (RISING)	0.0 (RISING) (1,500 c.f.s.)			22.0 (RISING) (50,800 c.f.s.)		NORMAL SETTING		
SECOND ALERT	1.5"	2.0"	WINTER 6 (RISING)	WINTER 15 (RISING)	1.0 (RISING) (1,800 c.f.s.)			AS INSTRUCTED				
	(Or As Instructed)		As Instructed	As Instructed								
INITIAL REGULATION	2.0" (Or As Instructed)	3.0	As Instructed	As Instructed	GROWING SEASON 1.5 (2,200 c.f.s.) NON-GROWING 2.0 (2,400 c.f.s.)			GROWING SEASON 25 NON-GROWING 28 OR AS INSTRUCTED		DISCHARGE SHOULD NOT EXCEED 1,250 c.f.s.	DISCHARGE SHOULD NOT EXCEED 350 c.f.s.	
II - CONTINUATION OF REGULATION	3.0" (Or As Instructed)	4.0"	As Instructed	As Instructed	3.0*	3.5	6.5	GROWING SEASON 28 NON-GROWING 30 OR AS INSTRUCTED	GROWING SEASON 18 NON-GROWING 20 OR AS INSTRUCTED	RESTRICT OUTFLOW TO MINIMUM RELEASES		
III - EMPTYING THE RESERVOIRS	STORM HAS ABATED		THE SAFE DOWNSTREAM CHANNEL CAPACITY FOR BIRCH HILL NON-GROWING SEASON IS 2,800 C.F.S., TULLY 800 C.F.S.: GROWING SEASON BIRCH HILL 2,000+ C.F.S., TULLY 650 C.F.S.									

EMERGENCY OPERATING PROCEDURE (EOP)
(During Communication Failure with RCC)
Gate operative for any of the following conditions:

	Partial Closure		Complete Closure	
Birch Hill	1'-1'-1'-1'		0'-0'-0'-0.1'	
Tully	0'-1'		0'-0.1'	
	Nongrowing	Growing	Nongrowing	Growing
Precipitation				
Wet Ground	1.5"	1.5"	2.0"	2.0"
Dry Ground	2.0"	2.0"	3.0"	3.0"
Main St. Athol	2.0'	1.5'	3.0'	2.0'
Montague City	26'	25'	28'	28'

Refer to paragraph 33.

NOTES:
1. Emptying the reservoirs shall not be initiated until contact has been established with RCC.
2. The rate of increase in reservoir discharge from Birch Hill Dam shall not exceed 500 cfs/hour up to 2,000 cfs and 200 cfs/hour over 2,000 cfs. The rate of increase from Tully Lake shall not exceed 200 cfs/hour up to 600 cfs and 50 cfs/hour over 600 cfs.
3. Maximum rate of reservoir drawdown should not exceed: Birch Hill - 5 feet/24 hours Tully - 5 feet/24 hours
4. Refer to paragraph 30e for snowmelt regulation.
5. Refer to paragraph 12c for ice jam flooding.
6. Refer to paragraph 30h for rising pool road closures.
*7. Refer to Phase III, paragraph 30d for operation instructions with regard to Main Street Athol stages.
8. If spillway discharge is anticipated, refer to paragraph 30f on gate release schedule above spillway crest elevations.

FLOOD CONTROL DAM OPERATOR

PHASE I
1. COLLECT AND TRANSMIT RAINFALL AND STAGE DATA TO RCC.
2. OPERATE ACCORDING TO INSTRUCTIONS FROM RCC.

PHASE II
1. OPERATE ACCORDING TO INSTRUCTIONS FROM RCC.
2. NOTE ALL UNUSUAL CONDITIONS AT DAM, DOWNSTREAM CHANNELS AND INDEX STATIONS.
3. COLLECT AND TRANSMIT RAINFALL AND STAGE DATA AT MINIMUM 3-HOUR INTERVALS OR AS DIRECTED BY RCC.

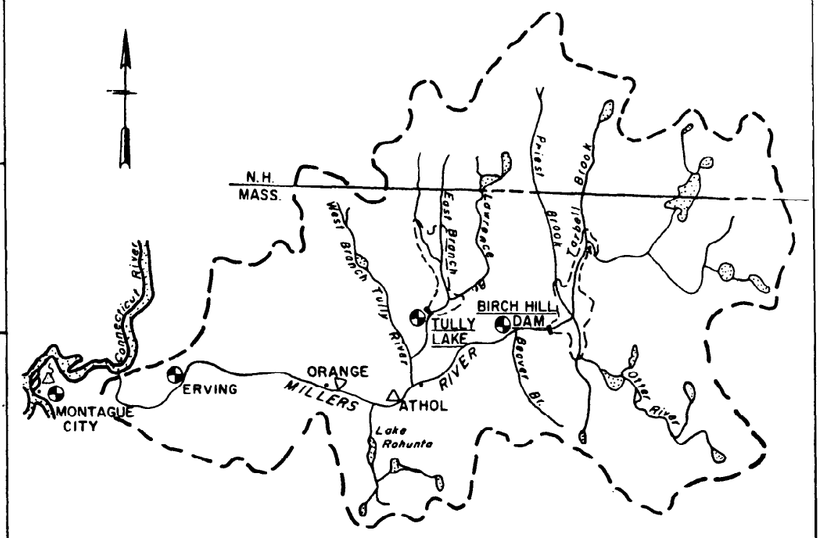
PHASE III
1. CONTINUE PHASE II, STEP 3.
2. RECONNOITER DOWNSTREAM CHANNELS AND POTENTIAL DAMAGE AREAS.
3. REPORT TO RCC FOR FURTHER INSTRUCTIONS.

PROJECT REGULATOR

PHASE I
1. COMPILE DATA.
2. PLAN AND COORDINATE NEXT TRANSMISSION TO DAM OPERATORS.
3. RESTRICT OUTFLOW TO MAINTAIN SAFE DOWNSTREAM CHANNEL CAPACITIES.
4. INFORM CONNECTICUT RIVER BASIN REGULATOR OF ACTIONS.

PHASE II
1. CONTINUE REGULATION INSTRUCTIONS TO DAM OPERATORS.
2. CONSULT WITH BASIN REGULATOR TO ANALYZE SEVERITY OF FLOOD.
3. COORDINATE REGULATION WITH CONNECTICUT RIVER BASIN REGULATOR.

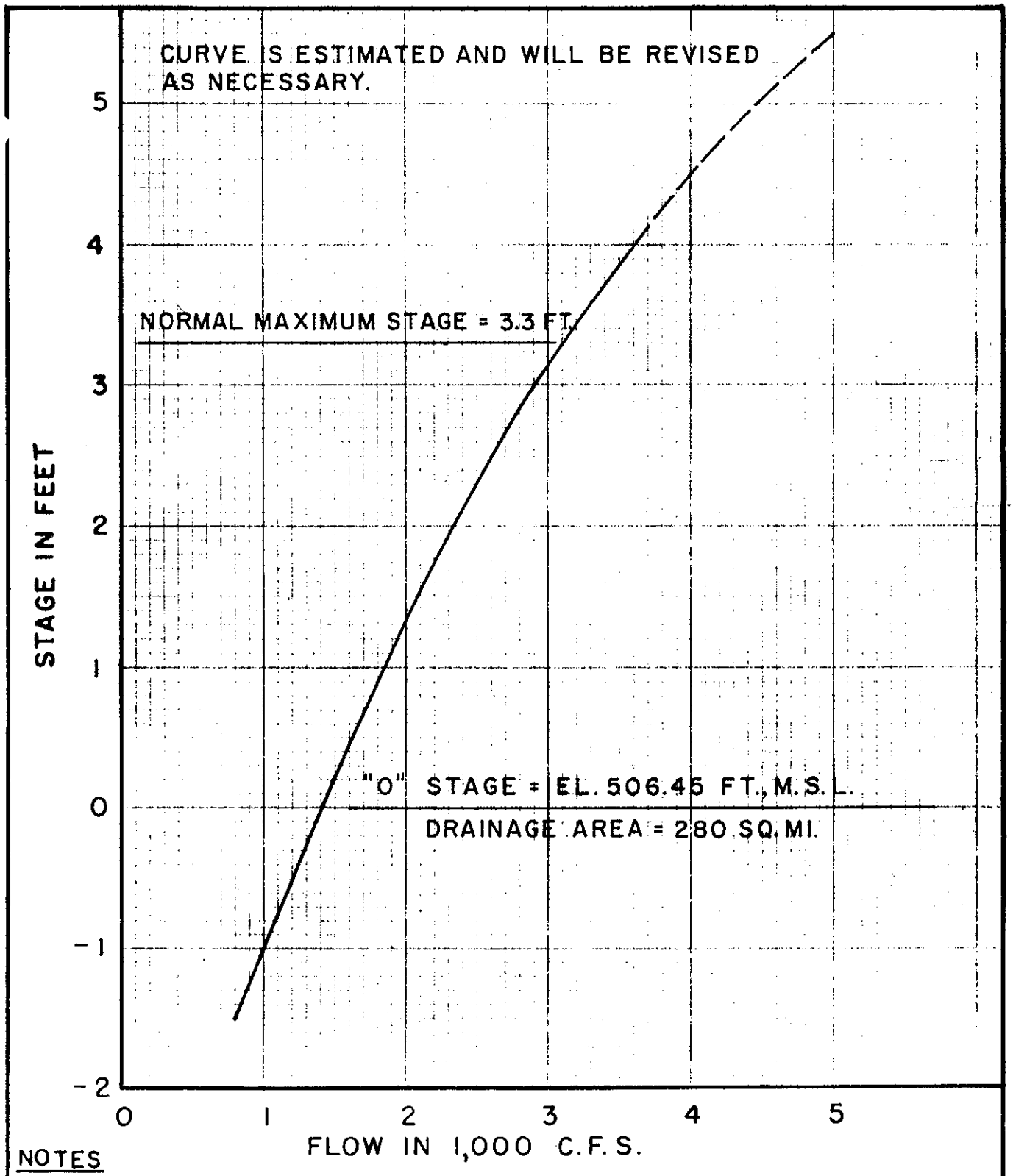
PHASE III
1. COLLECT DATA FROM DAM OPERATORS.
2. CHECK GUIDE CURVES FOR ALLOWABLE RELEASES.
3. CONSULT WITH CONNECTICUT RIVER BASIN REGULATOR.
4. TRANSMIT INSTRUCTIONS TO DAM OPERATORS.



LEGEND
- U.S.G.S. RECORDING STREAM GAGING STATION
- TELEMARK
- STAFF GAGE

AVERAGE PEAK TRAVEL TIMES

BIRCH HILL DAM TO ATHOL - 4-5 hrs
TULLY LAKE TO ATHOL - 2-3 hrs
ATHOL TO ORANGE - 2-3 hrs
ORANGE TO MOUTH OF MILLERS RIVER - 6 hrs.
MOUTH OF MILLERS RIVER TO MONTAGUE CITY - 2 hrs.



NOTES

MORTON MEADOWS HOUSING DEVELOPMENT CONTROLS MAXIMUM STAGES.

CONTACT RESIDENTS WHEN RESERVOIR RELEASES WILL RESULT IN STAGE AT OR ABOVE 3.0 FT.

WATER IN STREET AT STAGE OF ABOUT 3.3 FT.

WATER REACHES FLOOR JOISTS AND UTILITIES AT ABOUT 3.8 FT.

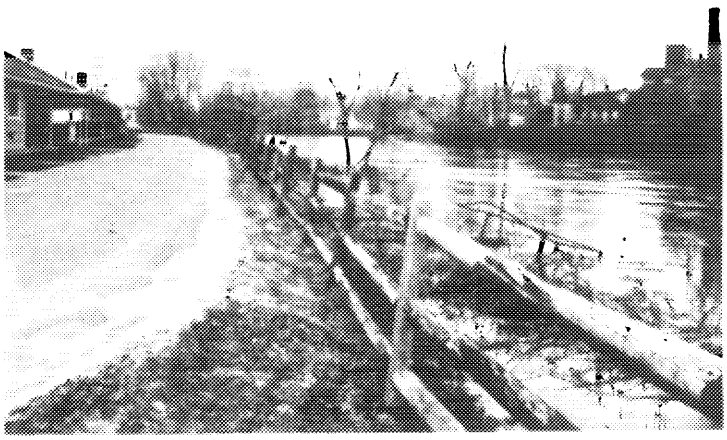
CONNECTICUT RIVER FLOOD CONTROL

MAIN STREET BRIDGE AT ATHOL, MASS.

RATING CURVE

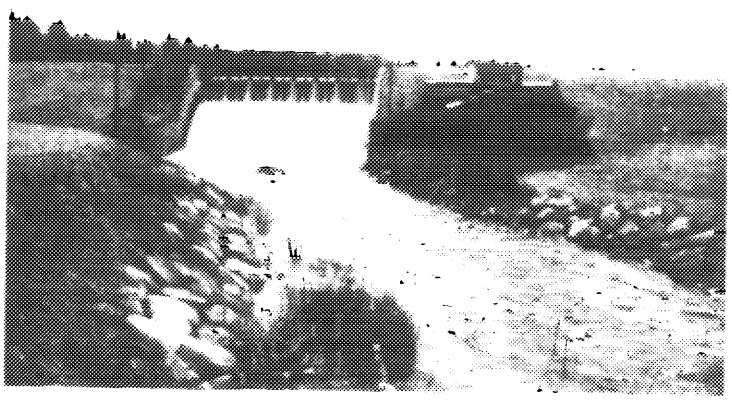
NEW ENGLAND DIVISION, WALTHAM MASS.
APRIL 1974

PLATE F-49



MORTON MEADOWS
HOUSING DEVELOPMENT
ATHOL, MASS.

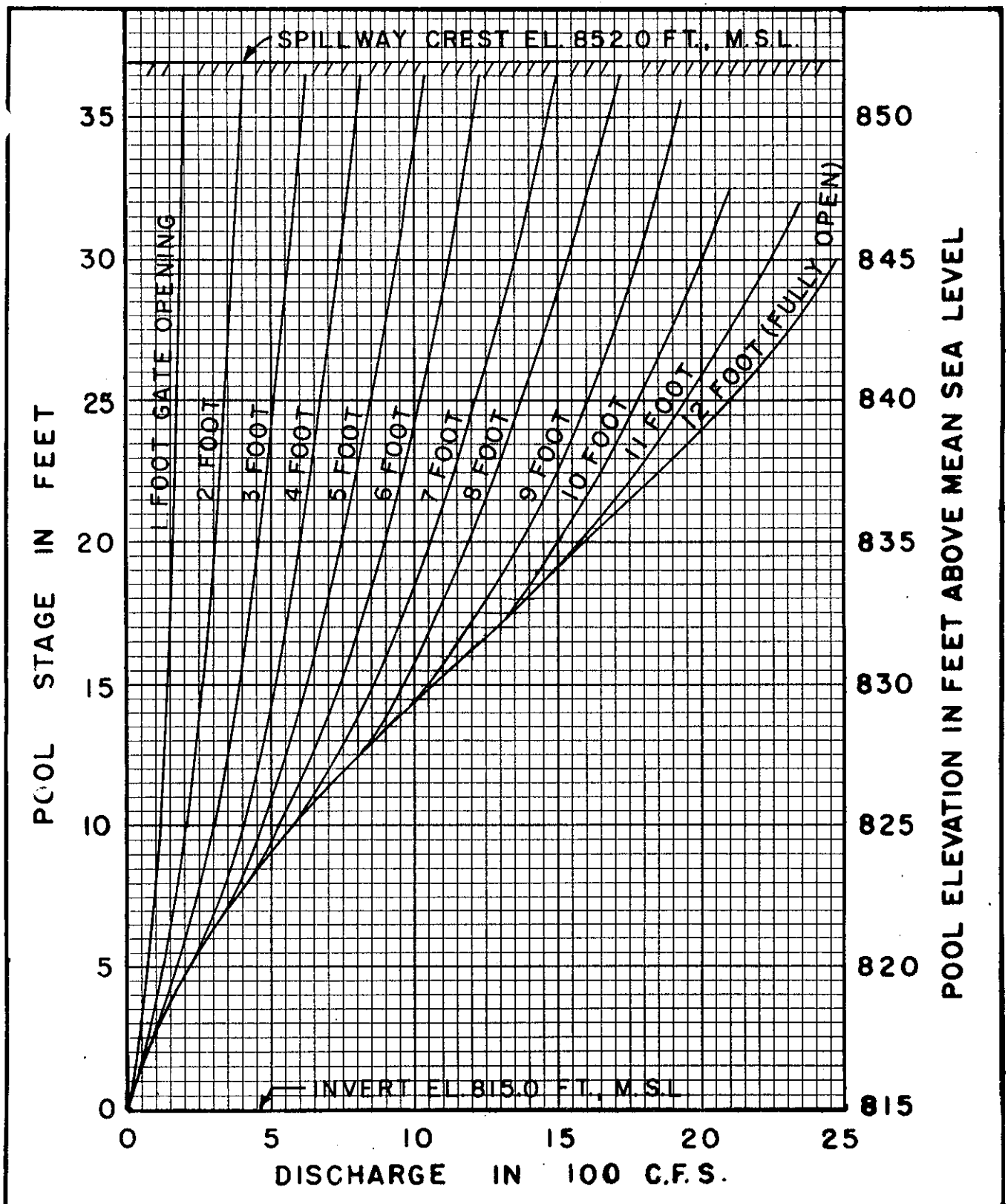
1,500 FEET DOWNSTREAM
MAIN STREET GAGE VIEW
LOOKING UP STREAM
STAGE=2.8'



LAKE ROHUNTA DAM
ATHOL, MASS.

TYPE- EARTH FILL
LENGTH- 630'±
HEIGHT- 23'±
SPILLWAY LENGTH- 40'
FLASHBOARDS- 8(4'x5.5')
DRAINAGE AREA- 20.3 SQ. MI.

PLATE F-50



FOUR 6'-0" WIDE X 12'-0" HIGH GATES
FOUR 6'-0" WIDE X 12'-0" HIGH CONDUITS

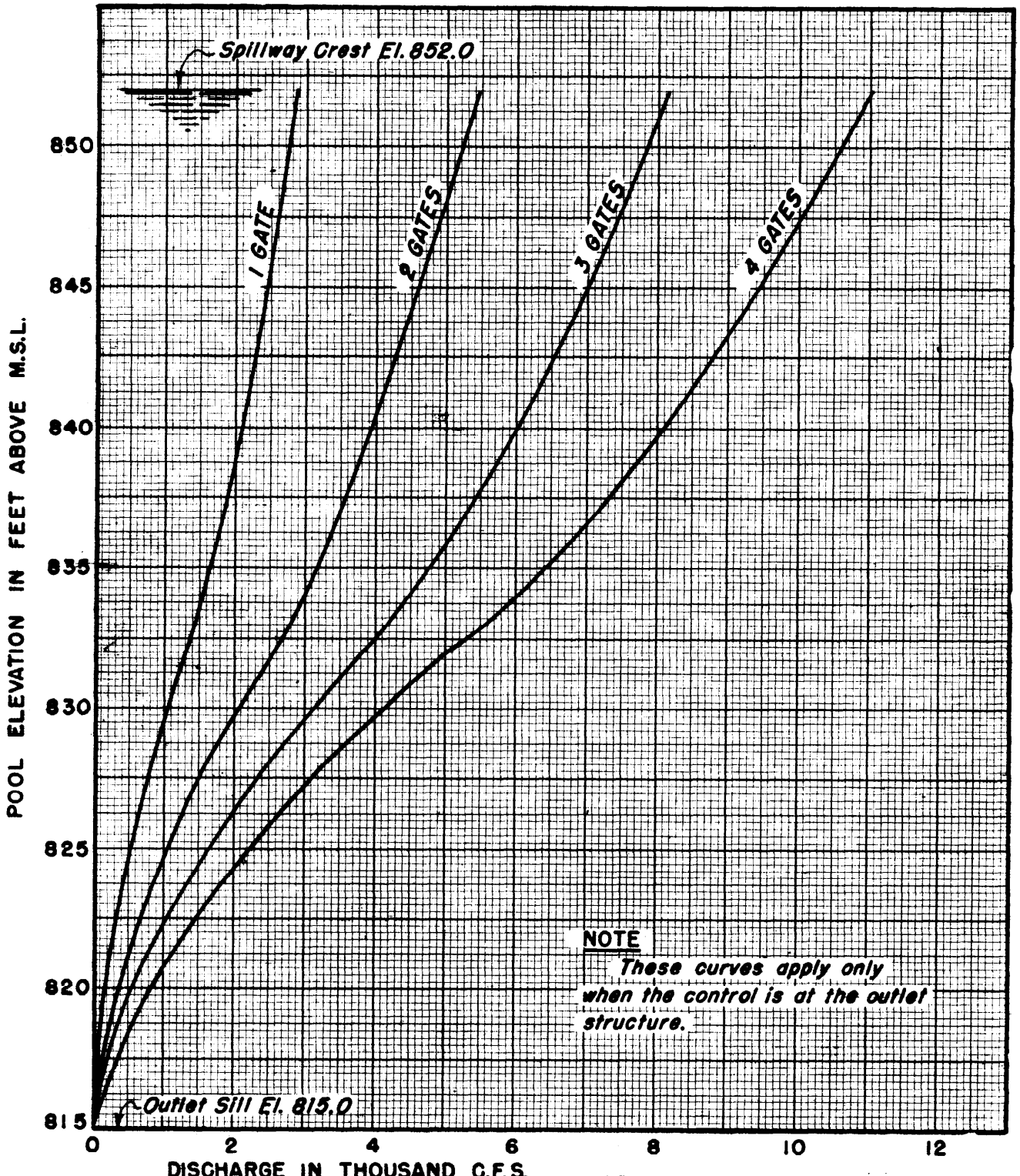
CONNECTICUT RIVER FLOOD CONTROL

BIRCH HILL DAM

OUTLET RATING CURVE FOR ONE GATE

NEW ENGLAND DIVISION, WALTHAM, MASS
APRIL 1974

PLATE F-51



MODEL RATIO 1:30

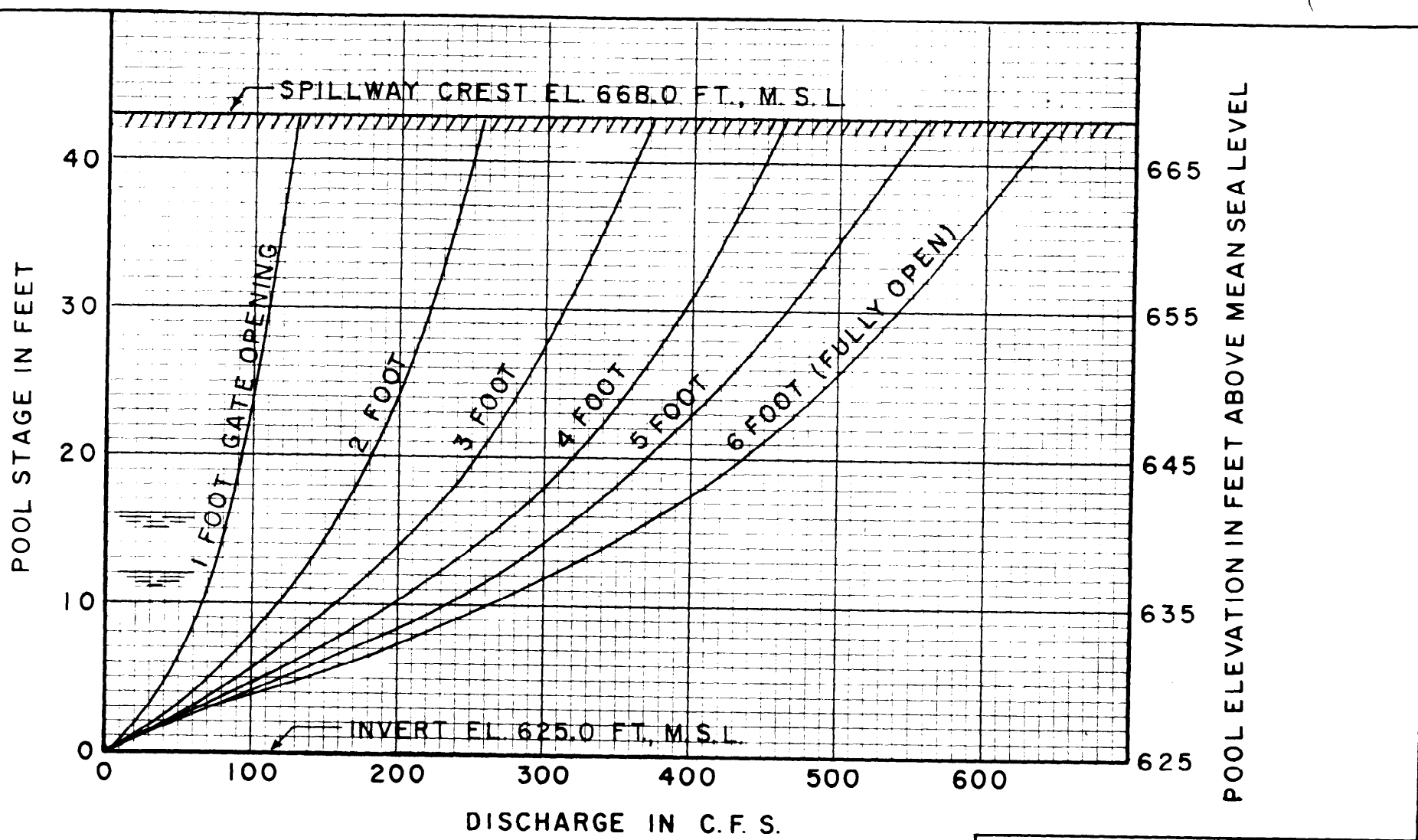
Tests at

Alden Hydraulic Laboratory

Worcester Polytechnic Institute

CONNECTICUT RIVER FLOOD CONTROL		
BIRCH HILL DAM OUTLET RATING CURVE		
U.S. ENGINEER OFFICE, PROVIDENCE, R.I.		
MAY 1941		FILE NO. CT-1-1634

PLATE F-52



NOTES:

TWO 3'-6" WIDE x 6'-0" HIGH GATES
6'-0" D. TUNNEL
SUMMER POOL - STAGE 16 FT.
WINTER POOL - STAGE 10 TO 12 FT.

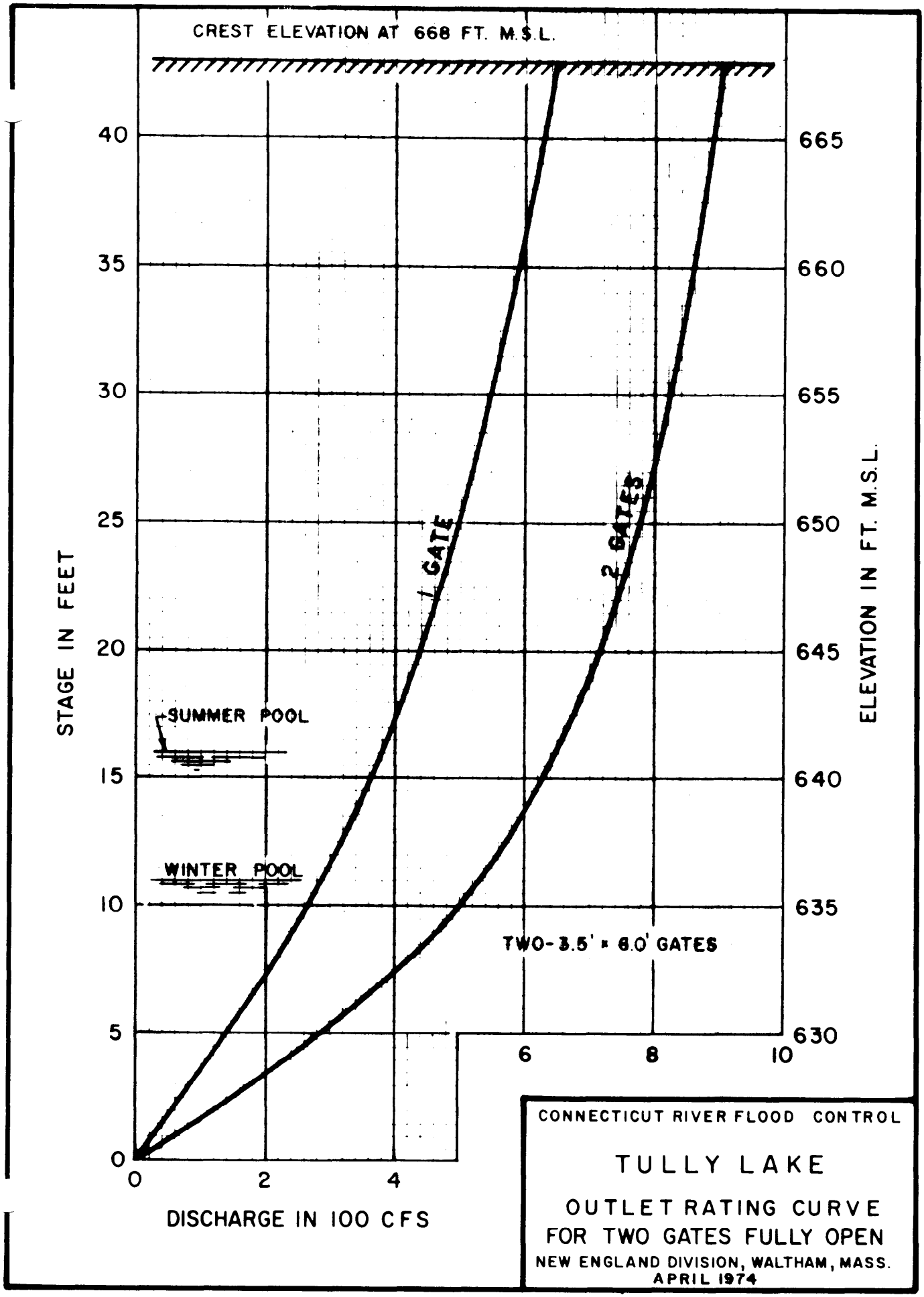
CONNECTICUT RIVER FLOOD CONTROL

TULLY LAKE

OUTLET RATING CURVE FOR ONE GATE

NEW ENGLAND DIVISION, WALTHAM, MASS.
APRIL 1974

PLATE F-53



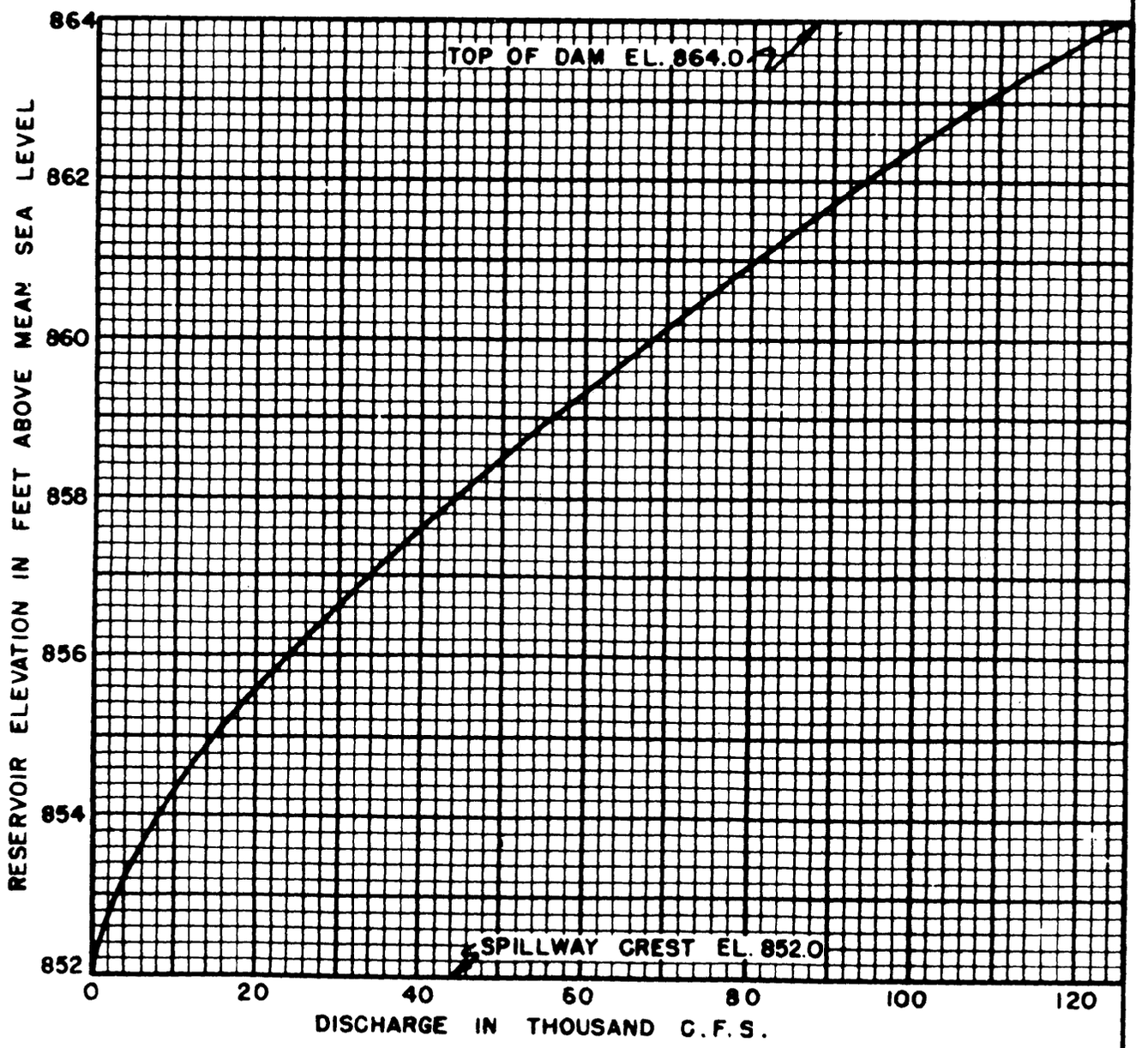
CONNECTICUT RIVER FLOOD CONTROL

TULLY LAKE

OUTLET RATING CURVE FOR TWO GATES FULLY OPEN

NEW ENGLAND DIVISION, WALTHAM, MASS.
APRIL 1974

PLATE F-54



NOTE: Weir No.1---- 720'
No.2---- 350'
No.3---- 23'
Total Length 1,093'

CONNECTICUT RIVER FLOOD CONTROL

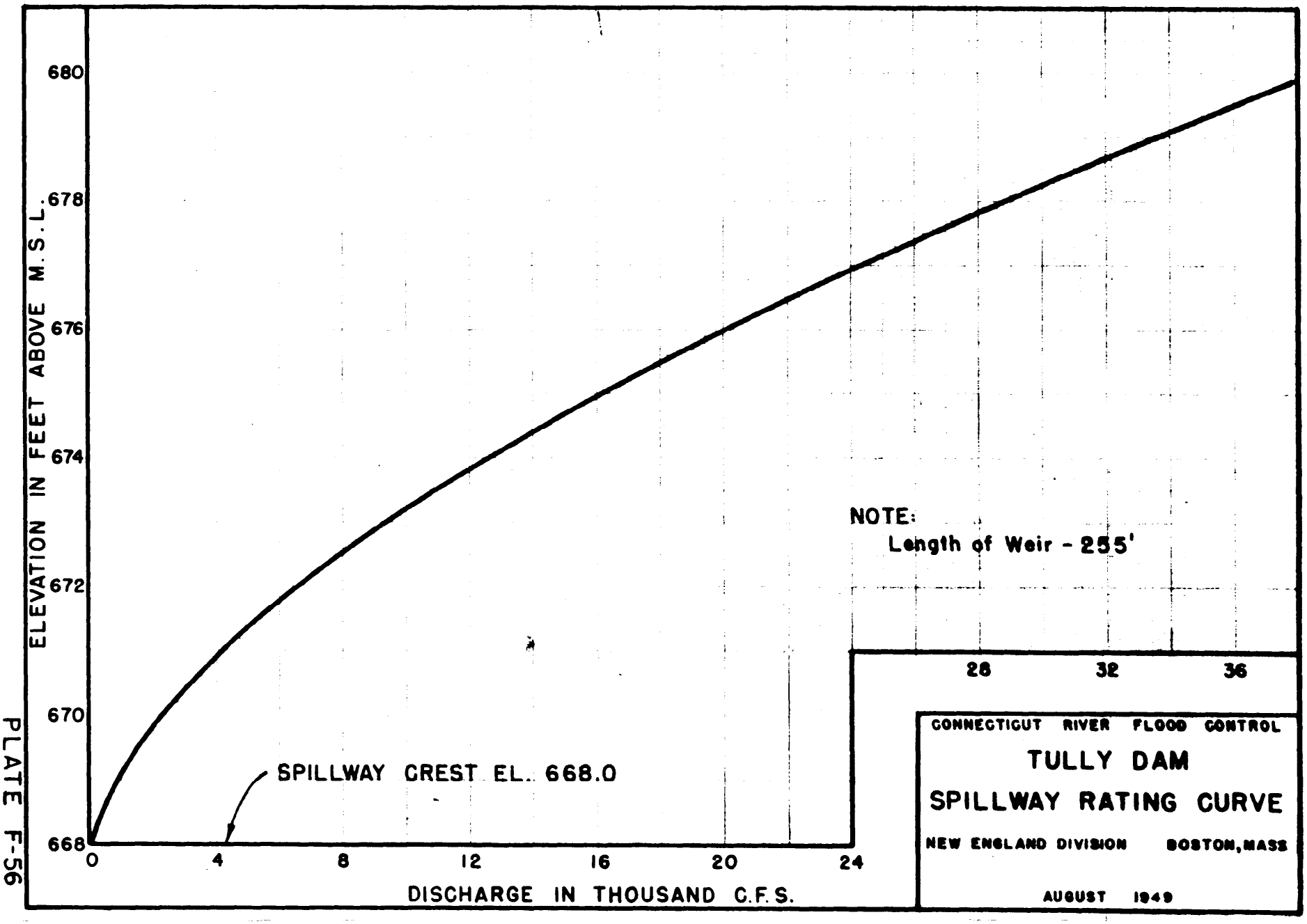
BIRCH HILL DAM

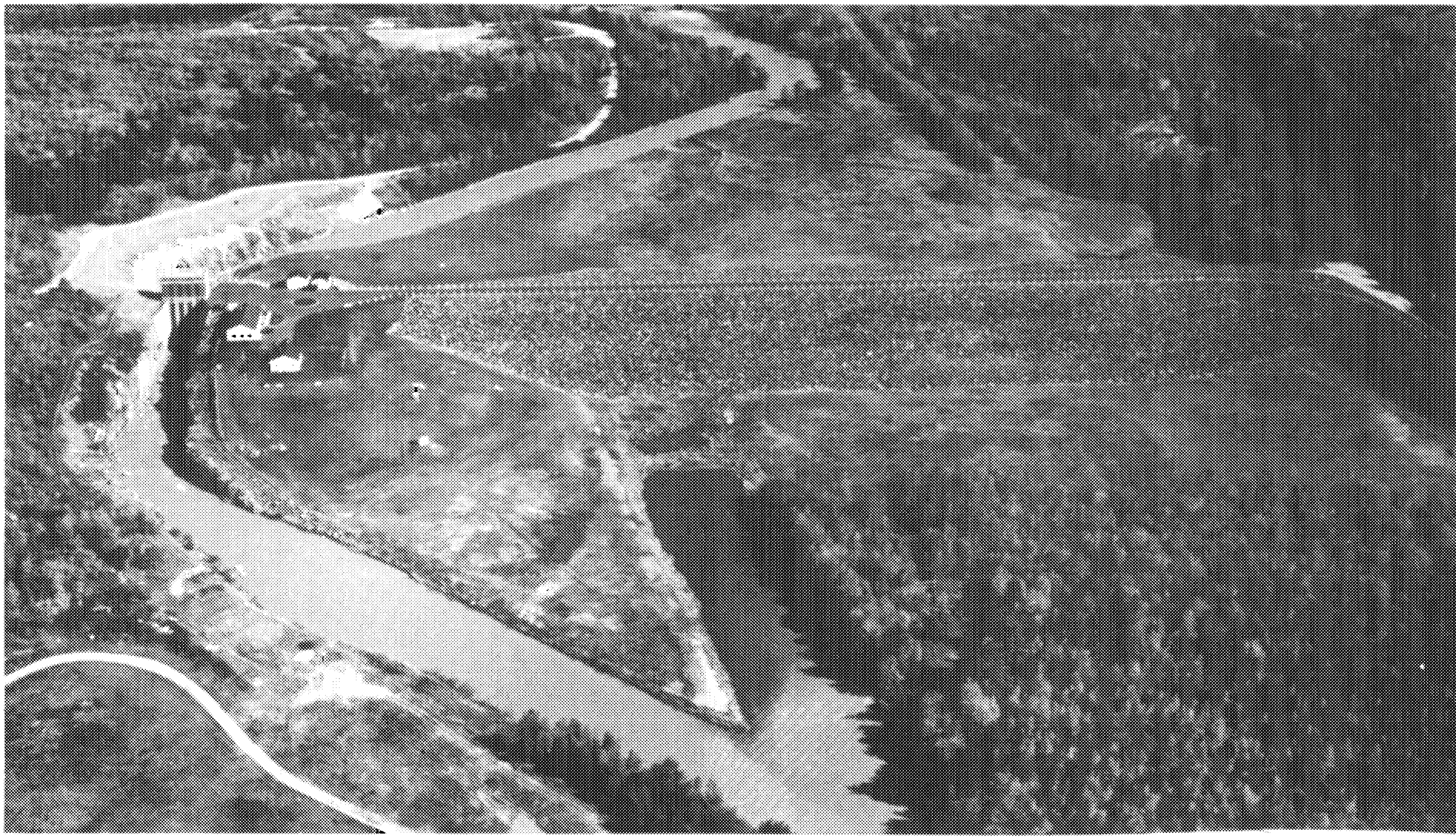
SPILLWAY RATING CURVE

NEW ENGLAND DIVISION BOSTON MASS

AUGUST 1949

PLATE F-55


680
678
676
674
672
670
668
ELEVATION IN FEET ABOVE M.S.L.
0
4
8
12
16
20
24
28
32
36
DISCHARGE IN THOUSAND C.F.S.
SPILLWAY CREST EL. 668.0
NOTE:
Length of Weir - 255'
CONNECTICUT RIVER FLOOD CONTROL
TULLY DAM
SPILLWAY RATING CURVE
NEW ENGLAND DIVISION BOSTON, MASS
AUGUST 1949
PLATE F-56



VIEW OF BIRCH HILL DAM

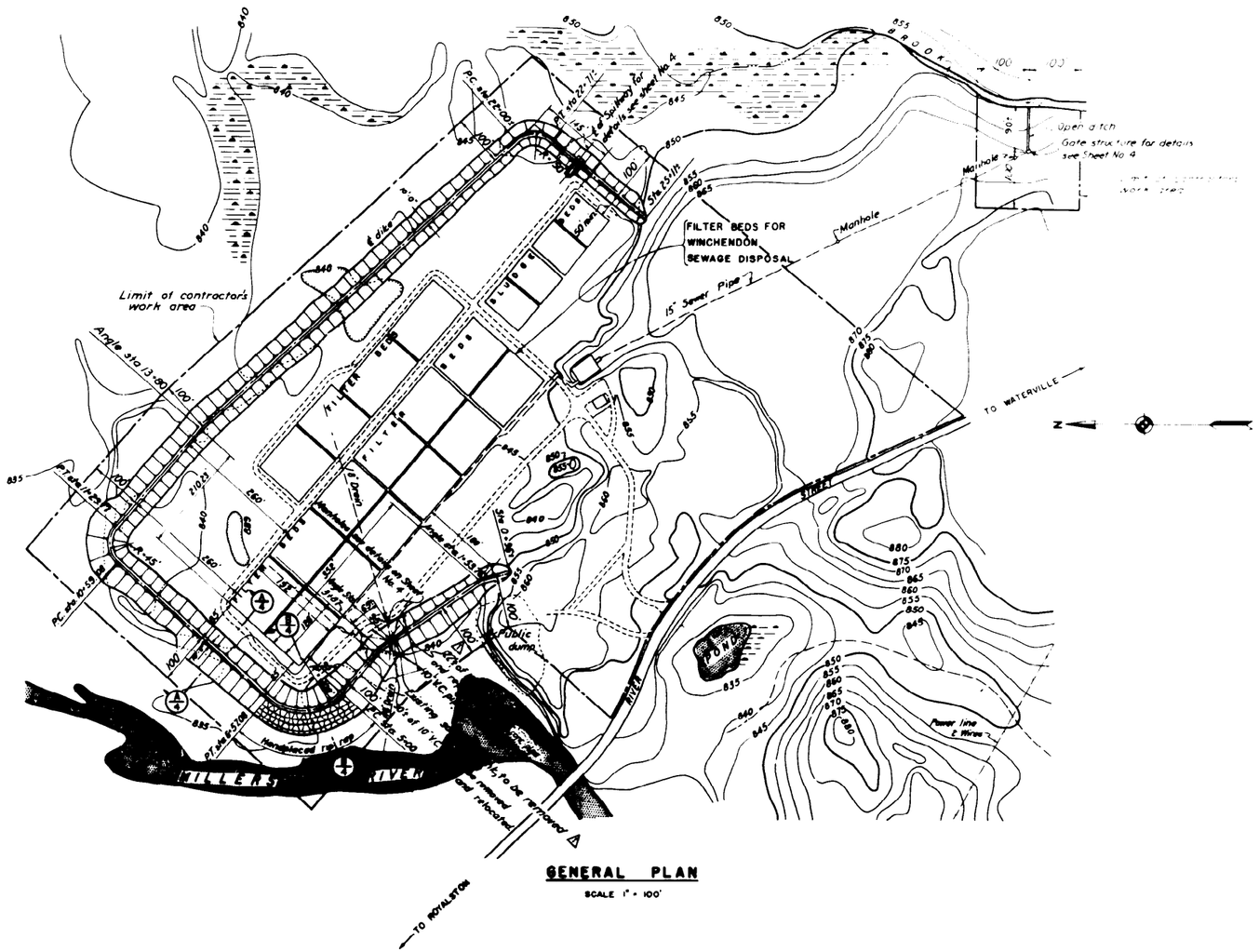
PLATE F-57

PLATE F-58

VIEW OF TULLY LAKE

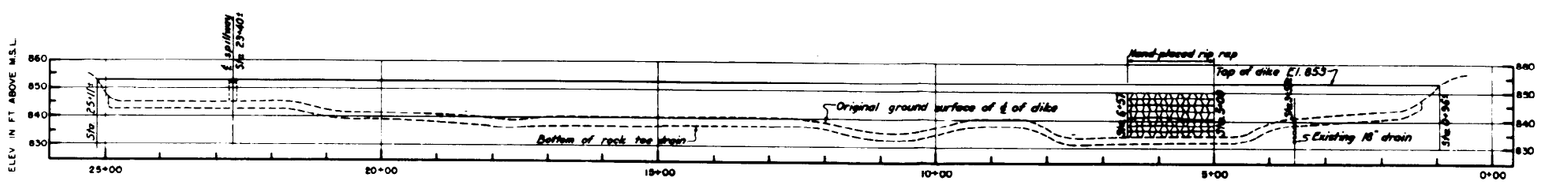
WAR DEPARTMENT

CORPS OF ENGINEERS, U S ARMY



GENERAL PLAN

SCALE 1" = 100'



PROFILE OF ℄ OF DIKE

SCALE HOR. 1" = 100'
VERT. 1" = 20'

RECORD DRAWINGS

CONNECTICUT RIVER FLOOD CONTROL

BIRCH HILL RESERVOIR

PROTECTION OF FILTER BEDS

PLAN AND PROFILE

MILLERS RIVER MASSACHUSETTS

IN 4 SHEETS SCALE 1 IN. = 100 FT. SHEET NO. 2

U.S. ENGINEER OFFICE, PROVIDENCE, R.I. JAN. 1941

KEY	DATE	REVISION - Indicated by △	REV. BY	CK. BY	AP. BY
1	9/25/41	Sampling tank removed 18"PC pipe P.C.t			

SUBMITTED: Senior Engineer, Head, Design Section

APPROVAL RECOMMENDED: Principal Engineer, Chief, Engineering Div.

APPROVED: Lt. Col. Corps of Engineers, District Engineer

DESIGNED: Asst. Engineer

DRAWN

TRACED

CHECKED

FILE NO. CT-4-2775

PLATE F-52

CHASE TURBINE COMPANY DAM
ORANGE, MASSACHUSETTS

TYPE - CONCRETE
LENGTH DAM - 175' ±
SPILLWAY LENGTH - 80' ±

FLASHBOARDS - 9(4' x 6')
DRAINAGE AREA - 316 SQ. MI.

PLATE F-60